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SOCIOECONOMIC IMPACTS OF WATER QUALITY STRATEGIES

by

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Contract #68-03-2618

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16. ABSTRACT

This publication provides in one place comprehensive guidance on socioeconomic assessment for planners and engineers involved in areawide water quality or facilities planning. It provides a set of methods and techniques for considering socioeconomic impacts in the water quality planning process. Socioeconomic impacts considered include those in the following impact categories: fiscal effects, employment effects, individual costs and benefits, land use and growth effects, public service impacts, sensory impacts, public health effects, and historic resource impacts.

The guidebook is divided into two parts. Part 1 presents a prototypical socioeconomic impact assessment process and guidelines for integrating it into the overall water quality planning process. Four assessment activities are discussed in the context of water quality management planning: impact identification, impact measurement, impact evaluation, and impact mitigation. Techniques for each of these activities are discussed and examples presented.

Part 2 considers techniques for estimating the impacts of water quality controls for the above impact categories. Socioeconomic issues, impact indicators, and measurement techniques are presented for each impact category.

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the research and the user community.

Before pollution control technology is implemented in a given area, it requires critical evaluation. In particular, it must be shown to be cost-effective and to minimize environmental impacts. An additional area of concern that merits consideration in the evaluation process is the issue of socioeconomic impacts. EPA in recent years has recognized the importance of land use impacts, financial burden, and community disruption in water quality management planning. This publication provides in one place comprehensive guidance on socioeconomic assessment for planners and engineers involved in areawide water quality or facilities planning.

Francis T. Mayo
Director
Municipal Environmental
Research Laboratory

ABSTRACT

This guidebook provides a set of methods and techniques for considering socioeconomic impacts in the water quality planning process. Socioeconomic impacts considered include those in the following impact categories: fiscal effects, employment effects, individual costs and benefits, land use and growth effects, public service impacts, sensory impacts, public health effects, and historic resource impacts. These types of impacts have typically not been given adequate consideration in water quality planning.

The guidebook is divided into two parts. Part 1 presents a prototypical socioeconomic impact assessment process and guidelines for integrating it into the overall water quality planning process. Four assessment activities are discussed in the context of water quality management planning: impact identification, impact measurement, impact evaluation, and impact mitigation. Techniques for each of these activities are discussed and examples presented. A particular emphasis of the guidebook is on alternatives evaluation, rather than on assessing the impacts of a "best" alternative. The types of water quality strategies discussed in Part 1 include conventional and alternative wastewater techniques, stormwater management controls, hydrographic modifications, water conservation controls, industrial wastewater controls, growth management controls, and other non-point source controls.

Part 2 considers techniques for estimating the impacts of water quality controls for the above impact categories. Socioeconomic issues, impact indicators, and measurement techniques are presented for each impact category.

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TABLE OF CONTENTS

Page

Disclaimer........ ii
Foreword........ iii
Abstract........ iv
Contents........ v
List of Exhibits........ x
List of Examples........ xiii
Acknowledgments........ xvi

1. INTRODUCTION........ 1

1.1 Purpose of this Guidebook........ 1
1.2 Summary of Technical Approach........ 2
1.3 Organization of this Guidebook........ 5

PART 1: IMPACT ASSESSMENT GUIDELINES........ 6

2. SOCIOECONOMIC IMPACTS AND WATER QUALITY STRATEGIES........ 7

2.1 Introduction........ 7
2.2 Water Quality Control Strategies........ 7
2.3 Socioeconomic Impact Categories........ 12
2.4 How Socioeconomic Impacts Occur from Water Quality Strategies: Direct Impacts........ 16
2.5 How Socioeconomic Impacts Occur from Water Quality Strategies: Indirect Impacts........ 19

3. IMPACT IDENTIFICATION........ 27

3.1 Introduction........ 27
3.2 Impact Identification Procedures........ 28

Page

4. IMPACT MEASUREMENT 41
- 4.1 Introduction 41
- 4.2 Basic Impact Measurement Concepts 41
- 4.3 Impact Measurement Procedures 47

5. IMPACT EVALUATION 64
- 5.1 Introduction 64
- 5.2 Determining the Significance of an Impact 65
- 5.3 Screening Techniques 68
- 5.4 Comprehensive Evaluation Technique: Balance Sheet Method 75
- 5.5 Comprehensive Evaluation Technique: Goals Achievement Account 77
- 5.6 Comprehensive Evaluation Technique: Linear Additive Utility Function 80
- 5.7 Determining a Community Preference 81
- 5.8 Summary 88
- 5.9 References 89

6. IMPACT MITIGATION 91
- 6.1 Introduction 91
- 6.2 Types of Mitigation Measures 91
- 6.3 Selection and Evaluation of Mitigation Measures 92

PART 2: IMPACT MEASUREMENT TECHNIQUES 101

7. PUBLIC FISCAL 102
- 7.1 Impact Description 102
- 7.2 Impact Indicators 105
- 7.3 Preliminary Considerations 108
- 7.4 Measurement Techniques 108
- 7.5 Data Requirements 115
- 7.6 References 118

Page

8. PRIVATE FIRM COSTS.................................... 119

8.1 Impact Description.................................. 119
8.2 Impact Indicators................................... 123
8.3 Preliminary Considerations.......................... 126
8.4 Measurement Techniques.............................. 135
8.5 Data Requirements................................... 138
8.6 References.. 145

9. EMPLOYMENT AND ECONOMIC GROWTH........................ 147

9.1 Impact Description.................................. 147
9.2 Impact Indicators................................... 150
9.3 Preliminary Considerations.......................... 152
9.4 Measurement Techniques.............................. 152
9.5 Data Requirements................................... 159
9.6 References.. 159

10. PRIVATE INDIVIDUAL COSTS AND BENEFITS................ 163

10.1 Impact Description................................. 163
10.2 Impact Indicators.................................. 170
10.3 Preliminary Considerations......................... 170
10.4 Measurement Techniques............................. 171
10.5 Data Requirements.................................. 178
10.6 References... 178

11. LAND USE, HOUSING, AND POPULATION.................... 181

11.1 Impact Description................................. 181
11.2 Impact Indicators.................................. 187
11.3 Preliminary Considerations......................... 190
11.4 Measurement Techniques............................. 191
11.5 Data Requirements.................................. 208
11.6 References... 213

Page

12. OTHER PUBLIC SERVICES.. 215

12.1 Impact Description.............................. 215
12.2 Impact Indicators............................... 220
12.3 Preliminary Considerations...................... 220
12.4 Measurement Techniques.......................... 223
12.5 Data Requirements............................... 233
12.6 References...................................... 233

13. RECREATIONAL OPPORTUNITIES................................... 236

13.1 Impact Description.............................. 236
13.2 Impact Indicators............................... 239
13.3 Preliminary Considerations...................... 240
13.4 Measurement Techniques.......................... 241
13.5 Data Requirements............................... 244
13.6 References...................................... 244

14. HISTORIC RESOURCES... 246

14.1 Impact Description.............................. 246
14.2 Impact Indicators............................... 249
14.3 Preliminary Considerations...................... 251
14.4 Measurement Techniques.......................... 256
14.5 Data Requirements............................... 257
14.6 References...................................... 257

15. SENSORY.. 262

15.1 Visual Quality.................................. 262
15.2 Noise... 272
15.3 Odors... 281

Page

16. PUBLIC HEALTH AND SAFETY.................................... 288

16.1 Impact Description.................................... 288

16.2 Impact Indicators.................................... 290

16.3 Preliminary Considerations.................................... 291

16.4 Measurement Techniques.................................... 292

16.5 Data Requirements.................................... 297

16.6 References.................................... 299

APPENDIX A: POTENTIAL SOCIOECONOMIC IMPACTS OF WATER QUALITY STRATEGIES.................................... 300

A-1 Introduction.................................... 301

A-2 On-Site Systems.................................... 302

A-3 Centralized Wastewater Systems.................................... 310

A-4 Residuals Management.................................... 325

A-5 Industrial Wastewater Controls.................................... 334

A-6 Infiltration/Inflow and Combined Sewer Controls....... 339

A-7 Domestic Water Conservation.................................... 342

A-8 Urban Stormwater Source Controls.................................... 348

A-9 Urban Stormwater Flow Attenuation Controls............ 352

A-10 Urban Stormwater Storage/Treatment Facilities......... 358

A-11 Urban Soil Erosion Controls.................................... 362

A-12 Agricultural Source Controls.................................... 367

A-13 Growth Management Controls.................................... 374

A-14 Hydrographic Modifications.................................... 384

APPENDIX B: IMPLEMENTATION FEASIBILITY.................................... 388

APPENDIX C: FINANCIAL SCREENING PROCEDURES.................................... 400

APPENDIX D: STATE HISTORIC PRESERVATION OFFICERS............... 415

EXHIBITS

Number		Page
2-1	Typical Water Quality Physical Controls and Management Practices	9
2-2	Components of a Water Quality Control Strategy: Urban Stormwater Flow Attenuation Strategy	13
2-3	Physical Control Features and Socioeconomic Impacts	18
2-4	Socioeconomic Issues Associated with Public Financing Mechanisms	20
3-1	Major Groups Potentially Affected by Water Quality Strategies	29
6-1	Types of Mitigation Measures for Socioeconomic Impacts of Water Quality Management Strategies	94
7-1	Public Fiscal Data Sources	117
8-1	Major Factors Affecting Farmer's Selection of Water Quality Control Option	124
8-2	A Portion of the Standard Industrial Classification Manual: 1972	125
8-3	Typical Response of Industries to Local Sewer Charges and Surcharges	131
8-4	Industrial and Commercial Firm Costs Data Sources	143
8-5	Agricultural Firm Costs Data Sources	144
9-1	Employment Impacts Associated with Water Quality Strategies	151
9-2	Employment and Economic Growth Data Sources	160
10-1	Housing Cost Components	169
10-2	Typical Housing Cost Components	172

Number Page

10-3 Water Quality Strategy Impacts on Housing Costs 173

10-4 Private Individual Costs/Benefits Data Sources 179

11-1 Growth Pattern Determinants 185

11-2 Overview of the GEMLUP Land Use and Air Quality Impact Assessment Procedure 194

11-3 Sample GEMLUP Worksheets 195

11-4 List of Input Variables Needed to Predict Core Land Uses in the GEMLUP Model 197

11-5 REGION I Approach for Estimating Land Use Impacts of Wastewater Investments 200

11-6 Growth Potential Indicators 202

11-7 Decision Path for Step 6 Analysis 209

11-8 Wastewater Investment Impacts on Growth 210

11-9 Land Use Data Sources 211

11-10 Methods for Updating Land Use Information 212

12-1 Water Supply Indicators 221

12-2 Solid Waste Service Indicators 229

12-3 Full time Public Employees Per 1,000 Population and Pupils for Municipal and School District Services, by Municipal/School District Size and Region of the United States (North Central Region) 230

12-4 Public Services Data Sources 234

13-1 Recreational Opportunities Data Sources 245

14-1 Historic and Cultural Resources of Interest in Socioeconomic Assessment 248

14-2 Historic and Cultural Resources Impact Issues 250

14-3 Historic Resources Data Sources 260

Number		Page
15-1	Suggested Checklist for Visual Impacts	266
15-2	Typical Visual Assessment Methodologies	268
15-3	Visual Quality Data Sources	271
15-4	dBA Level and Relative Loudness of Typical Indoor and Outdoor Noises	274
15-5	EPA Identified Noise Levels Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety	277
15-6	Noise Impact Data Sources	282
15-7	Verbal Odor Descriptions	284
15-8	Odor Impact Data Sources	287
16-1	Hypothetical Damage Function	296
16-2	Public Health and Safety Data Sources	298

EXAMPLES

Number		Page
2-1	Indirect Impacts Associated with a Sewage Treatment Facility in Smithville	25
3-1	Worksheet WS-1: Summary of Water Quality Alternative	31
3-2	Worksheet WS-2: Description of Water Quality Components	32
3-3	Worksheet WS-3: Impact Identification Checklist: Direct Impacts	34
3-4	Potential Impact Incidence for Smithville Sewage Treatment Facility	37
4-1	Selected Impacts Associated with Proposed Smithville Sewage Treatment Facility	46
4-2	Temporal Dimensions of Socioeconomic Impacts for Smithville Sewage Treatment Facility	48
4-3	Impact Issues Screening Results	50
4-4	Impact Presentation: Population Increases Due to Regional Wastewater Treatment Plant	54
4-5	Impact Presentation: Annual Household User Cost Impacts of Regional Wastewater Treatment Plant	55
4-6	Impact Presentation: Visual Effects of Wastewater Treatment Plant	56
4-7	Impact Presentation: Historic Locations Affected by Interceptor Route A	57
4-8	Impact Presentation: Expected Wastewater Treatment Plant Noise Exposure in Rolling Hills Subdivision	58
4-9	Impact-Type Matrix	60
4-10	Alternative-Type Matrix	61
4-11	Area-Type Matrix	62

Number		Page
4-12	Area-Type Matrix	63
5-1	Conjunctive Screening	71
5-2	Conjunctive Screening	72
5-3	Disjunctive Screening	74
5-4	Lexicographic Screening	76
5-5	Ranked Balance Sheet Method Applied to Alternative Interceptor Routes for South River Basin	78
5-6	Scored Goals Achievement Account Applied to Alternative Interceptor Routes for South River Basin	79
5-7	Linear Additive Utility Function Approach Applied to Alternative Routes for South River Basin	82
5-8	Pareto-Optimality	86
6-1	Mitigation: Impact Prevention and Impact Management Measures	93
7-1	Total Water Quality Capital Costs/"Local" Costs	109
7-2	Changes in Annual Water Quality Costs	110
7-3	Debt Service Cost Calculation	111
7-4	Tax Rate Change Calculation for Smithville Sewerage Facilities	113
7-5	Revenue Calculation for Fees Associated with Water for New Growth	116
8-1	Calculation of Annual and Total ICR Payment Requirements for Lost River Sanitary District	128
8-2	Union City Firms Affected by Proposed Pretreatment Requirements	133
8-3	Treatment Cost Estimates	136
8-4	Annual Pollution Abatement Costs	137

Number		Page
8-5	Pollution Abatement Investment as a Percentage of Fair Market Value of Capital Stock	139
8-6	Annual Costs as a Percentage of Gross Annual Sales for Firms by Industry Type	140
8-7	Typical Sewer Surcharge Formula	141
8-8	Agricultural Cost Burden, Exeter County	142
9-1	Construction Worker Employment Impact of New Sewage Treatment Facility	154
9-2	Using an Employment Multiplier to Forecast Employment	155
9-3	Union City Firms Likely to Suffer Employment Losses	157
10-1	Average Annual User Costs for Proposed Smithville Sewer Project -- User Bears Total Cost	165
10-2	Average Annual Costs for Proposed Smithville Sewer Project -- Users and All Households Share the Cost	166
10-3	Household Tax Burden in Smithville Associated with Alternative Water Quality Strategies	175
11-1	Summary of Smithville Developable Land	204
11-2	Projected Smithville Housing Unit Increase	207
12-1	Projected Water Consumption Reductions by Smithville Industries in Response to Wastewater Controls	226
12-2	Solid Waste Impacts	231
12-3	Converting Personnel Demand into Costs: Two Approaches	232
14-1	Historic Resources Impact Worksheet	258

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CHAPTER 1

Introduction

1.1 PURPOSE OF THIS GUIDEBOOK

The National Environmental Policy Act (NEPA) has, since its inception in 1969, called for the assessment of socioeconomic impacts as part of the environmental assessment process. Despite this mandate, socioeconomic impacts have received spotty attention in the environmental assessments and impact statements that accompany wastewater facilities plans and areawide water quality planning efforts. Increasingly, however, socioeconomic issues, such as land use impacts and user charge impacts, are significant issues that shape public acceptance of water quality strategies.

EPA has recognized in recent years the growing importance of socioeconomic issues in water quality management planning in three important areas. Since January 1977, all Step I Facility Plans for Wastewater Treatment plans are required to identify the following:

- Estimated total capital costs for the recommended treatment works, a breakdown of estimated eligible and ineligible costs, and the estimated Federal, State, local governmental and industrial shares of the capital costs.

- The expected method of local financing and estimated annual debt service charges or taxes (based on the expected interest rate for municipal borrowing) on the total local capital cost of the recommended treatment works.

- Estimated annual operation and maintenance costs and the estimated industrial and local government's shares thereof for the recommended treatment works.

- The estimated monthly charge for operation and maintenance, the estimated monthly debt of service charge, the estimated connection charge, and the total monthly charge to a typical residential customer.

This requirement to consider bottom-line distribution of costs is of critical importance as the costs of wastewater treatment facilities increase rapidly. The 1977 Clean Water Act has also formalized EPA's concern that multi-use recreation opportunities be considered in the construction of wastewater facilities. Section 201 (6) of the Act stipulates that no wastewater treatment plan construction grants be awarded after September, 1978 to grant applicants until recreation and open space opportunities compatible with facilities have been adequately considered in the planning process.

The concern for the land use impacts of wastewater treatment facilities has received probably the most attention by EPA and others. The 1977 Clean Water Act and subsequent regulations now require a much more sensitive cost-effectiveness analysis to minimze the funding of excess capacity.

In short, there are two emerging trends for socioeconomic considerations in water quality planning: 1) environmental quality at any cost is not an adequate approach; 2) and an explicit accounting of costs, benefits, and other impacts should be considered in environmental decision-making. As concern for the consideration of socioeconomic impacts of water quality strategies has grown, however, it has become increasingly clear that there is a paucity of adequate guidance on how to identify, measure, evaluate, and mitigate socioeconomic impacts.

The purpose of this guidebook is to provide water quality planners with methods and techniques for considering socioeconomic impacts in the water quality planning process. The emphasis is on techniques for impact identification, measurement, evaluation, and mitigation. The procedural and regulatory aspects of the environmental assessment process are not the focus of the guidebook. While the guidebook is principally designed for areawide water quality management planning, it is also relevant to sewerage planning done under the Section 201 construction grants program.

1.2 SUMMARY OF TECHNICAL APPROACH

The guidebook discusses the socioeconomic impact process in terms of the following four modular activities:

- Impact Identification
- Impact Measurement
- Impact Mitigation

- Impact Evaluation

Each of these activities, summarized in Exhibit 1-1, is described in the guidebook and procedures for accomplishing these tasks are recommended. In many cases, alternative methods are proposed so that water quality planners may accomplish the socioeconomic assessment appropriate to their available resources. An important assumption of the approach in this guidebook is that socioeconomic assessment is a decision tool to assist water quality planners in evaluating alternatives. The identification and measurement of impacts should not be ends in themselves. Rather, socioeconomic impact information should be used along with information on costs, environmental impacts, effectiveness, and implementation feasibility to evaluate alternatives.

A major assumption in this guidebook is that equal water quality benefits will result from each alternative consideration. It is assumed that strategies that do not meet water quality standards will not be considered in the final evaluation process. The implication of this assumption is that some of the socioeconomic benefits associated with water quality, such as public health impacts, drinking water improvements, and some recreation benefits, are not directly considered in the guidebook since they are equal for each alternative and presumably not crucial in distinguishing among alternatives.

In addition to presenting a generic process for doing a socioeconomic assessment of water quality strategies, the guidebook has an explicit scope, both in terms of water quality strategies and socioeconomic impact categories. The types of water quality strategies examined in this guidebook are limited to the following:

- Conventional centralized wastewater treatment systems
- On-site and alternative wastewater treatment systems
- Residuals management
- Hydrographic modifications
- Infiltration/inflow and combined sewer controls
- Water conservation controls
- Industrial wastewater controls
- Urban stormwater source controls
- Urban stormwater flow attenuation controls
- Urban stormwater storage treatment controls

- Urban soil erosion controls
- Agricultural source controls
- Growth management controls.

This is a fairly inclusive list and should cover most of the types of water quality strategies that will be considered in either wastewater facilities planning or areawide water quality planning.

A number of socioeconomic impact categories were considered for inclusion in the guidebook. Based on a review of existing facility plans and areawide water quality plans, the following ten socioeconomic impact categories are included:

- Public Fiscal
- Private Individual Costs/Benefits
- Private Firm Costs
- Employment and Economic Growth
- Land Use/Housing/Population
- Other Public Services
- Recreational Opportunities
- Historic Resources
- Sensory
- Public Health and Safety

1.3 ORGANIZATION OF THIS GUIDEBOOK

The guidebook is organized into two parts:

Part 1: Impact Assessment Guidelines
Part 2: Impact Measurement Techniques

Part 1 focuses on the overall process of doing a socioeconomic assessment for water quality strategies. Chapter 2 first examines how socioeconomic impacts occur from water quality strategies. The characteristics of different control measures are reviewed and their relationship to socioeconomic impacts are discussed. Chapters 3 through 6 cover respectively the four activities that comprise a socioeconomic assessment - impact identification, impact measurement, impact evaluation, and impact mitigation. Numerous water quality strategy examples are used to highlight the discussion in these chapters.

Part 2 consists of ten chapters that cover specific impact measurement techniques for the ten socioeconomic impact categories of interest in this guidebook. These chapters are structured similarly with the following sections in each chapter: impact description, impact indicators, measurement techniques, data sources, and references. Numerous water quality strategy examples are also used in the text.

Two important appendices supplement the text. While Chapters 7 through 16 present the impact measurement side of the guidebook, Appendix A summarizes impacts by specific water quality control strategies. Each of the water quality control strategies listed above in Section 1.2 is briefly described and specific impact issues are listed in tabular form. This allows the user to use this guidebook in two ways: specific impact measurement techniques appropriate for any water quality strategy are explained in the text in Chapters 7 through 16; impact issues associated with specific water quality strategies are discussed in Appendix A.

Appendix B discusses an important issue that water quality planners should consider in evaluating water quality strategies, namely implementation feasibility. Unlike socioeconomic impacts which are the consequences of a strategy, implementation feasibility is concerned with the likelihood of a strategy being implemented. It encompasses political acceptability, legal authority, and administrative capacity issues. Implementation feasibility is a key issue for water quality planners to consider in conjunction with impact issues in evaluating water quality strategy alternatives.

PART 1

IMPACT ASSESSMENT GUIDELINES

CHAPTER 2
Socioeconomic Impacts and Water Quality Strategies

2.1 INTRODUCTION

Before proceeding with a discussion of how to conduct a socioeconomic assessment, it is useful to look at the relationship between water quality strategies and socioeconomic impacts. The purpose of this section is to examine how socioeconomic impacts occur from water quality strategies.

An understanding of the relationships between water quality strategies and socioeconomic impacts is crucial for the successful application of this guidebook in a particular water quality planning process. In short, you should have a conceptual understanding of how impacts occur. This chapter provides an initial conceptualization of socioeconomic impact occurrence.

Section 2.2 first defines and illustrates what is meant by a "water quality strategy". The type of impacts of interest in this publication are then briefly discussed in Section 2.3. Sections 2.4 and 2.5 look at how direct and indirect socioeconomic impacts, respectively, occur from water quality strategies. Appendix A presents a detailed and comprehensive checklist of potential socioeconomic impacts associated with specific water quality control categories.

2.2 WATER QUALITY CONTROL STRATEGIES

A sewer pipe is not a water quality control strategy. Neither is an urban stormwater detention pond a strategy. Both of these are physical controls for dealing with water quality problems. A water quality strategy encompasses three components:

- Physical controls or management practices

- Implementation measures
- Institutional arrangements

Physical controls or management practices are physical actions that modify or reduce pollutants. Controls include not only end-of-the-line approaches such as treatment plants but also any physical activity that modifies the physical generation of wastes in the waste stream process. Four general types of physical controls in water quality management include: reduction of waste generation; modification of wastes after generation in on-site, collection, or final treatment facilities; redistribution of wastes from one receiving media to another; and alteration of the assimilative capacity of the receiving media. Physical controls may range from simple management practices such as contour plowing used in agricultural erosion control to advanced wastewater treatment plants. Examples of each of typical controls are shown in Exhibit XX.

Implementation measures are the incentives or inducements that precipitate or spur an action. In order for physical control actions to take place, they must have some type of trigger to insure their implementation. These implementation measures may take a variety of forms, such as sewer use charges, sediment control ordinances, operation and maintenance manuals, or zoning by-laws. They may be regulatory, enforcement, economic or educational in nature.

Regulatory--

Regulatory mechanisms are fairly common implementation measures in water quality strategies. Examples range from local stormwater ordinances to EPA construction grants regulations. Water quality regulations can be typically classified by the features shown below.

Scope of Regulations	Type of Regulations	Administrative Mechanisms
• Regulate type of activities • Regulate location of activities • Regulate timing of activities • Regulate size or intensity of activities	• Specification standards • Performance standards • Discretionary standards • Plan conformance	• Permits • Licenses • Monitoring • Inspections

Exhibit 2-1

TYPICAL WATER QUALITY PHYSICAL CONTROLS AND MANAGEMENT PRACTICES

WATER QUALITY ISSUES	TYPES OF PHYSICAL CONTROLS AND MANAGEMENT PRACTICES (EXAMPLES)			
	Reduction in Waste	Modification of Wastes	Redistribution of Wastes	Alteration of Assimilative Capacity
Urban Stormwater	• Use of less salt in highway deicing programs • Street sweeping programs • Litter control programs	• Detention basins	• Groundwater recharge basins	• Instream aeration devices • Flow augmentation
Municipal Wastewater	• Water conservation • Segregation of garbage wastes from the wastewater stream on-site • Greywater systems	• Sewer lines • Wastewater treatment facility	• Land application	• Same as above
Industrial Wastewater	• Use of different materials in the industrial process • Segregation of solids from the wastewater stream • Water conservation	• Treatment and pretreatment facilities	• Land application • Separate discharge versus connection to a municipal facility	• Same as above

- Implementation measures
- Institutional arrangements

Physical controls or management practices are physical actions that modify or reduce pollutants. Controls include not only end-of-the-line approaches such as treatment plants but also any physical activity that modifies the physical generation of wastes in the waste stream process. Four general types of physical controls in water quality management include: reduction of waste generation; modification of wastes after generation in on-site, collection, or final treatment facilities; redistribution of wastes from one receiving media to another; and alteration of the assimilative capacity of the receiving media. Physical controls may range from simple management practices such as contour plowing used in agricultural erosion control to advanced wastewater treatment plants. Examples of each of typical controls are shown in Exhibit XX.

Implementation measures are the incentives or inducements that precipitate or spur an action. In order for physical control actions to take place, they must have some type of trigger to insure their implementation. These implementation measures may take a variety of forms, such as sewer use charges, sediment control ordinances, operation and maintenance manuals, or zoning by-laws. They may be regulatory, enforcement, economic or educational in nature.

Regulatory--

Regulatory mechanisms are fairly common implementation measures in water quality strategies. Examples range from local stormwater ordinances to EPA construction grants regulations. Water quality regulations can be typically classified by the features shown below.

Scope of Regulations	Type of Regulations	Administrative Mechanisms
● Regulate type of activities	● Specification standards	● Permits
● Regulate location of activities	● Performance standards	● Licenses
● Regulate timing of activities	● Discretionary standards	● Monitoring
● Regulate size or intensity of activities	● Plan conformance	● Inspections

Economic--

Governmental units can stimulate public and private water quality compliance actions by a variety of economic mechanisms.

Effluent Charges: These represent a system of charges on wastewater emissions designed to allocate scarce resources. Their principal purpose is to discourage an activity rather than to reflect actual costs associated with a strategy. Some user charges, however, may be set so high that they serve as an effluent charge or a disincentive.

Performance Bonds: These represent an obligation to pay a specified amount of money unless performance conditions are met. They serve as an insurance policy for public agencies regulating private actions.

Tax Incentives: Taxing policies which reduce or defer taxes to encourage a desired goal may be considered tax incentives. They represent subsidies from the public sector to the private sector.

Grants and Loans: These also are subsidies and they may be from the public sector to the private sector or from one level of the public sector to another level of the public sector.

Public Acquisition of Land: Public investments may be used to restrict development and other activities. The purchase of development rights, conservation easements, and purchase/lease back arrangements are all mechanisms by which land-related activities may be restricted.

Private Transfer of Development Rights: Unlike the public purchase of development rights discussed above, this mechanism involves the transfer of development rights totally within the private sector. A public agency may act as a broker in transactions.

Not included in the above list of economic incentives and disincentives are such items as water quality-related fees, user charges, industrial cost recovery payments, and assessments. These all represent financing mechanisms discussed below under institutional arrangements. In essence, they are payments or compensation for services received and provided for at public expense. When these mechanisms are implemented in situations where public wastewater facilities are being used without adequate compensation, they may serve, however, as an economic disincentive. Thus, the implementation of sewer user charges in communities that previously financed wastewater systems by ad valorem taxes has stimulated a reduction in waste from some water-using industries.

Education--

Educational incentives may be provided under a variety of umbrellas--public information programs, training programs, technical assistance, guidebooks/manuals, workshops. These devices can be used by the public sector to influence private sector compliance or by one level of the public sector to influence public sector compliance at another level. In relation to regulatory and economic incentives and sanctions, these mechanisms involve relatively low key approaches in seeking compliance.

Educational incentives may be used in conjunction with other incentives to achieve water quality compliance. For example, EPA and the states use a multi-incentive approach in attempting to deal with operation and maintenance problems of local public wastewater treatment plants. Operator training programs, O&M manuals, and technical assistance--all educational incentives--are used with regulatory, financial assistance, and enforcement to stimulate better O&M.

Enforcement--

Enforcement sanctions involve both administrative and judicial actions that seek to compel compliance. These range from informal administrative orders, such as warning letters, to formal administrative sanctions, such as permit revocation. More stringent judicial sanctions when invoked may include fines, penalties, or damage recoveries.

Institutional arrangements, the third component of a water quality control strategy, encompasses the institutions and arrangements to manage and finance a water quality strategy.

Number and Type of Management Responsibilities--

Generally, a water quality planning agency will have to designate agencies which will bear responsibility for implementing the structural controls and the implementation measures. The number and type of responsibilities that will require management will be dependent on the needs of the structural and non-structural controls. The selection of institutional arrangements is by no means, however, necessarily sequenced after the other components. Institutional design should be coordinated simultaneously with the other components. There are also a number of "implementation feasibility" issues to consider in developing institutional arrangements. Implementation feasibility analysis involves a judgment as to the likelihood that a particular strategy can be achieved, and includes administrative, legal, and political considerations. See Appendix B for a discussion of implementation feasibility considerations for water quality strategies.

Distribution of Management Responsibilities--

Management responsibilities may be split along several lines:

Public/Private Sector Responsibility: For both technical compliance and administrative requirements, some management responsibilities may be distributed among private and public entities. For example, a management strategy for on-site septic systems might include public ownership of septage trucks.

Geographic Scope of Responsibility: The planning agency feasibility analysis for institutional strategies will define a feasible geographic scope of responsibility appropriate for different functions. Alternatives include countywide or local, state, areawide, special district, or interstate configurations. A particular strategy may involve a multi-jurisdictional approach. For example, a sediment control strategy may involve state standards; local permitting, review,and enforcement functions; and technical assistance via the district Soil Conservation Service.

Functional Scope of Responsibility: Water quality management responsibilities may be given to non-water quality oriented agencies. These may include agencies whose primary functions are storm drainage, land use management, or solid waste management. While there are important implementation feasibility questions surrounding these designations, there may also be related socioeconomic impacts.

Type of Agency: Many types of agencies may be involved in water quality management, such as line agencies of general purpose government (state, federal, local); special districts; public authorities; and quasi-governmental agencies.

Public Financing Mechanisms--

While costs, type of implementation measures, and institutional arrangements have all been shown to be critical factors affecting public and private costs associated with water quality strategies, one of the most important factors shaping impacts is the type of mechanism used to finance public-related costs. Public financing is necessary to fund both capital and operational costs associated with water quality strategies. There are equity considerations that have to be addressed in the development of financing schemes. For the water quality planning agency, these equity considerations may be as significant as least-cost criteria and implementation feasibility criteria. The principal public financing mechanisms to fund local water quality costs include: bonds, grants and loans, general revenues, customer contributions, and user charges.

Exhibit 2-2 illustrates the components of a water quality strategy addressing urban stormwater.

2.3 SOCIOECONOMIC IMPACT CATEGORIES

The specific types of socioeconomic impacts used in this guidebook represent a judgement as to the socioeconomic issues that are most likely to be encountered in local and regional water quality planning. Not all of the socioeconomic issues discussed in this guidebook may be relevant in a particular water quality planning context; similarly, there may be

12

Exhibit 2-2

COMPONENTS OF A WATER QUALITY CONTROL STRATEGY: URBAN STORMWATER FLOW ATTENUATION STRATEGY

COMPONENTS	DEFINITIONS	EXAMPLES
Control Methods/ Management Practices	Physical actions that modify or reduce pollutants by: ● changing the amount, type, timing, or spatial location of pollutants ● altering the assimilative capacity of the receiving media	● Stormwater detention ponds ● Temporary ponding areas -- rooftops, parking lots, playgrounds
Implementation Measures	Incentives or inducements that stimulate or spur a physical action, such as surcharges, regulations, technical assistance, grants, enforcement sanctions	● Regulatory -- storm drainage ordinances ● Economic -- emission charges based on stormwater quantity/ acre ● Economic -- density bonuses for acceptable storm drainage designs ● Economic -- performance bonds to assure adequate design
Institutional Arrangements	Institutions, both public and private, that will perform the necessary management functions, such as implementation, operation, financing, monitoring	● Local Public Works Department -- design standards, plan review, construction, operational financing, maintenance ● Private Developers -- construction, capital financing

additional categories of concern not covered in this guidebook.

Since the focal point of this guidebook is principally on impacts of water quality plans at the local and regional level, the selection of socioeconomic impact categories for this guidebook has concentrated on socioeconomic issues of interest to local and regional water quality planners. For example, shifts in product prices that result from pollution control abatement that may be of interest at the national level are not discussed here. Income changes, on the other hand, are not discussed here because a review of the literature revealed that income changes from water quality strategies were difficult to identify.

The selection of the socioeconomic categories to be included in a guidebook of this type is complicated by the lack of agreement as to what constitutes a socioeconomic assessment. The basic legislation guiding environmental assessment in this country, the National Environmental Policy act (NEPA), provides only broad guidance on the subject. The categories used in this guidebook have been selected with regard to these recent judicial decisions, recent social science research, socioeconomic assessment manuals developed for other types of projects, a literature review of water quality projects and plans, and from discussions with water quality planners.

As discussed in the Introduction in Chapter 1, it is assumed in this guidebook that only alternatives that meet water quality standards are considered for socioeconomic assessment. Thus, it is assumed that equal water quality benefits will accrue to each of the alternative strategies for a particular water body. For the purposes of this guidebook, which is primarily interested in distinguishing impacts associated with different alternatives, the impacts associated with water quality are not important. These impacts may affect recreational opportunities, public health, land values, and water supply. While these water quality benefits are not of direct concern here, the water quality planner may wish to consider them.

Public Fiscal

This category includes changes in public revenues and expenditures. The focus in this guidebook is at the local and regional level. Direct expenditures may include capital and operations and maintenance costs for public facilities and regulatory and management costs associated with public regulation. Changes in other public service costs will also produce indirect changes in revenue and expenditures. Revenue changes will be affected by user charges, by outside cost sharing opportunities, and by changes in tax base and tax revenues.

The public fiscal impact category represents a distribution point for many water quality strategy costs. Costs are eventually distributed to individuals and firms via a variety of public financing mechanisms including user charges, property and other taxes, and expendicture cut in other public services.

Private Individual Costs/Benefits

This category is concerned with direct and indirect water quality-related costs incurred by individuals--users of wastewater programs, non-users, homeowners, land owners. Of particular interest are changes in wastewater costs, property taxes, and real estate values.

Private Firm Costs/Benefits

This category is concerned primarily with three groups potentially affected by water quality strategies--industrial/commercial firms, developers/builders, and agricultural producers. The types of costs incurred by these groups include direct compliance costs--capital, O&M, and regulatory--and non-user costs reflected in property taxes.

Employment and Economic Growth

Changes in employment will result from water quality strategies in several ways. There will be direct employment changes associated with the construction of facilities. Employment changes will also occur from locational or plant closing changes associated with water quality strategies. There may also be multiplier effects, i.e, direct employment changes will produce indirect changes in demand for labor and support services.

Land Use Housing and Population

This category is primarily concerned with the effect water quality strategies have on growth patterns, i.e., the location, amount, type, density, and rate of growth. Domestic wastewater systems and growth management controls, are particularly important for this impact category. Land use impacts, in turn, are influential in stimulating a variety of other impacts. Housing and population changes are considered in this category.

The pre-emption of land for public and private facilities is also an impact issue in this category.

Public Services

In addition to affecting local and regional sewerage systems, water quality strategies may also affect other public services in an area. Changes in the demand, capacity, and performance are of interest in this category. Water supply, solid waste, drainage are public services directly affected by a variety of water quality strategies. In addition, growth changes will stimulate changes in other public services.

Recreational Opportunities

This category is similar to the public services category in that changes in demand, capacity, and performance are issues of interest. Since direct not of concern in this guidebook, the direct socioeconomic issues in this category primarily relate to multiple use opportunities and changes in accessibility resulting from water quality strategies. In addition, effects of population growth are also of interest in this category.

Historic Resources

This category is concerned with direct damages in physical accessibility to historic resources, alteration or displacement of historical resources, and changes in value or importance of historic resources. In addition to the direct effects associated with construction, many of the historic impacts from population growth and sensory impacts.

Sensory

Three major socioeconomic issues are included in this category--visual impacts, noise impacts, and odor impacts. The primary concern here is with direct adverse impacts resulting from the nuisance aspects of operating or building a facility. Indirect visual impacts associated with growth impacts are also considered in this category.

Public Health/Safety

In addition to water quality benefits associated with water quality, there are a variety of specific public health and safety impacts that may occur from water quality strategies. Public safety issues may arise in connection with the construction and operation of facilities; with the use of stormwater detention facilities in residential neighborhoods; and with reductions in road salt on heavily-travelled highways. Public health impacts are also quite heterogeneous and may occur in land application of wastewater and from stormwater detention ponds that breed mosquitoes. A potential indirect impact is the air quality impact associated with land use effects of sewage treatment facilities.

2.4 HOW SOCIOECONOMIC IMPACTS OCCUR FROM WATER QUALITY STRATEGIES: DIRECT IMPACTS

Discussed below are the features or characteristics of water quality strategy components that stimulate socioeconomic impacts. It should be emphasized that these features or characteristics of control strategies are useful in identifying potential impact issues. Impacts occur when the characteristics and provisions of a strategy interact with the conditions existing at the location where the strategy is employed. Many socioeconomic impacts are highly influenced by site-related factors. Sensory, historic, and public service impacts, for example, are very dependent on site-specific

Physical Controls/Management Practices

There are a variety of features of physical controls that stimulate impacts including the following:

- Physical features
- Capacity
- Resource inputs
- Physical by-products
- Construction activities
- Operating characteristics

Location is a unique issue that shapes each of the above characteristics in stimulating impacts. Certain features, such as construction activities, may not have any socioeconomic effects. But when combined with location, the construction activities may affect historic resources or produce sensory impacts for an adjacent area. Typical socioeconomic impacts associated with physical controls or management practices are shown in Exhibit 2-3.

Implementation Measures

Not only will implementation measures influence the effectiveness of control strategies, but they will also stimulate socioeconomic impacts. Regulatory and economic incentives have the most potential for stimulating impacts. For example, stormwater control ordinances, pretreatment ordinances, erosion control ordinances, and sewer surcharges--all of these generally induce private sector compliance costs as well as public fiscal administrative costs as seen below.

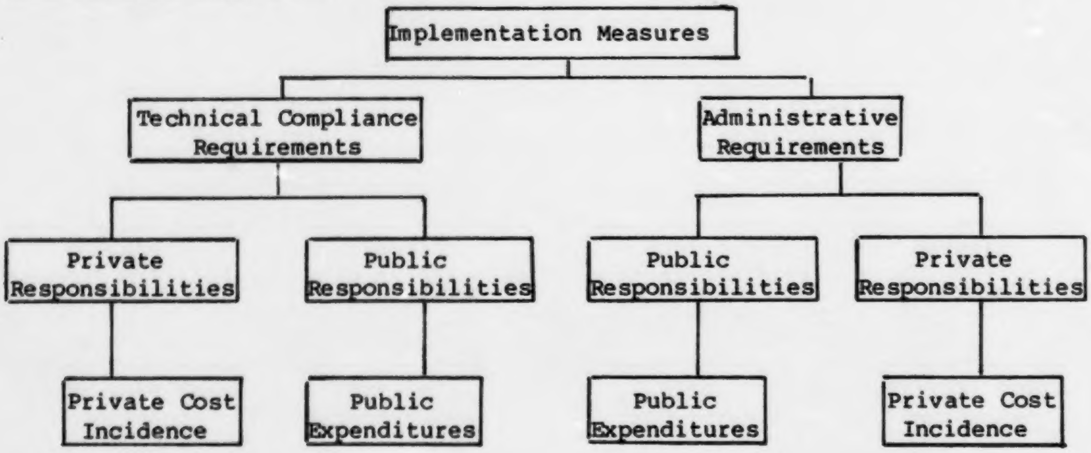


Exhibit 2-3
PHYSICAL CONTROL FEATURES AND SOCIOECONOMIC IMPACTS

FEATURE	SPECIFIC CHARACTERISTICS	STRUCTURAL CONTROLS (EXAMPLES)	DIRECT IMPACT ISSUE(S)
Physical	Size, height, form, lighting	Wastewater facilities; stormwater detention ponds; hydrographic controls; incinerators	Sensory
Capacity	Amount	Wastewater facilities	Land use; private firm costs; individual costs; public fiscal
Resource inputs	Land	Any land intensive water quality strategy, such as certain wastewater facilities; urban stormwater facilities	Land use--land pre-emption
By-products	Wastewater -- sludge residuals	Wastewater facilities	Land use--land reclamation; agricultural benefit--fertilizer
	Wastewater -- water reuse	Wastewater facilities	Agricultural benefit--irrigation; public services--water supply
	Wastewater/stormwater --groundwater recharge	Wastewater facilities; stormwater detention ponds	Public services--water supply
	Flood control	Stormwater facilities; hydrographic controls (dams)	Public safety
	Multiple use area	Wastewater facilities, particularly land application systems; stormwater detention reservoirs	Recreational opportunities
Construction activities	Nuisance aspects	Large scale facilities, such as wastewater facilities	Sensory
	Physical alterations	Stormwater facilities; wastewater facilities, particularly sewer lines	Historic resources; public services --water supply, traffic
	Excavations	Stormwater facilities; sewer lines	Public safety
Operating characteristics	Nuisance aspects	A number of facilities	Sensory
	Malfunctions	Wastewater facilities	Public health

Institutional Arrangements

The type and distribution of socioeconomic impacts associated with institutional arrangements will depend on the following factors:

- The number and type of management responsibilities to be performed;
- The distribution of responsibilities;
- The public financing methods used to finance public control strategies and to finance implementation measures.

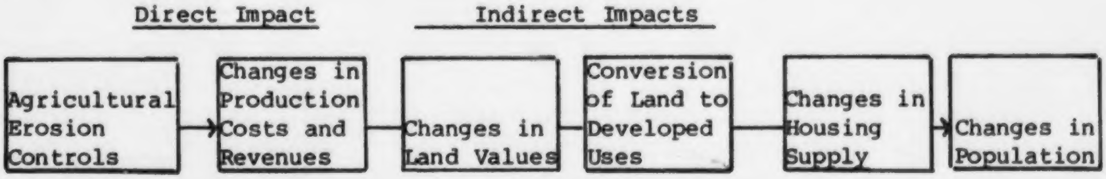
Obviously, the greater the number of management functions to be performed by a public agency, the greater the potential for increased public expenditures. The size of the impact, however, will be affected by public/private sector distribution of responsibilities and by the geographic distribution of responsibilities among agencies.

Public finance mechanisms represent a means of further distributing public costs to the private sector--to firms and individuals. Examples of how costs (and other impacts) can be distributed by alternative public financing approaches are shown in Exhibit 2-4.

2.5 HOW SOCIOECONOMIC IMPACTS OCCUR FROM WATER QUALITY STRATEGIES: INDIRECT IMPACTS

If the socioeconomic impact identification process stopped with the identification of direct impacts, i.e., those attributable directly to the proposed strategy, it would fail to capture many of the most significant impact issues. Indirect impacts represent those impacts that are stimulated by the direct impacts themselves.

For example, a water quality strategy that imposes erosion controls on farmers might result in changes in the farmer's production costs and/or crop income. These direct cost and revenue changes may, in turn, stimulate the impact chain shown below:


Direct Impact
Indirect Impacts
Agricultural Erosion Controls
Changes in Production Costs and Revenues
Changes in Land Values
Conversion of Land to Developed Uses
Changes in Housing Supply
Changes in Population

The impact chain could, of course, go on further as population changes may trigger changes in public service demand, employment, land use, recreational opportunities, etc.

Exhibit 2-4

SOCIOECONOMIC ISSUES ASSOCIATED WITH PUBLIC FINANCING MECHANISMS

Public Financing Mechanism	Definition	Uses/Examples	Impact Issues
(1) General Obligation Bonds	These bonds are backed by the "full faith and credit" of the issuer and are generally financed by ad valorem property taxes and/or revenues from service charges.	Generally used for capital costs, such as: • public wastewater treatment facilities • public stormwater detention facilities	These bonds typically carry lower interest rates than revenue bonds and therefore can favorably affect public expenditures. Amount of indebtedness incurred under this mechanism may be limited by stature; this may require tradeoffs in financing other community projects affecting other public services. Borrowing, of course, by any means, raises local indebtedness and may affect bond ratings and future borrowing potential. This may also affect other public services projects and may raise borrowing costs and thus affect public expenditures. See discussion below (#7,8,9) for impacts associated with revenue sources for bonds--property taxes, user charges, and special assessments.
(2) Revenue Bonds	In this type of bond, payments are derived strictly from charges for services provided.	These bonds, generally used for capital costs, are not used by new institutions or for new projects for which lenders can evaluate revenue potential. They are used in cases where charges can be easily matched with uses or services provided and are particularly attractive in situations where statuatory limitations prohibit additional debt via general obligation bonds.	These bonds typically carry higher interest charges than general obligation bonds and thus will increase public expenditures for a project. The indebtedness/bond ratings/borrowing costs issue, discussed above, is also relevant here and may affect total public expenditures. Because revenue bonds are not limited by debt ceilings, other public service projects requiring borrowing may not be affected adversely by this mechanism. See also User Charge impacts below.
(3) Special Assessment Bonds	A special assessment bond is financed through revenues from "special benefit assessments". The assessments are based on benefits accruing to properties affected by a project.	These bonds, generally used for capital costs, are often used for financing collection sewers and local drainage projects where property benefits are relatively easy to establish.	Higher interest costs are normally associated with this mechanism because of risk--this will affect total public expenditures for projects. The indebtedness/bond ratings/borrowing costs issue, discussed above, is also relevant here and may affect total public expenditures. Because special assessment bonds are not limited by debt ceilings, other public service projects requiring borrowing may not be affected adversely by this mechanism. Special assessment impacts may be similar to above for GO bonds.

Exhibit 2-4 (Continued)

Public Financing Mechanism	Definition	Uses/Examples	Impact Issues
(4) Grants/Loans	These are cost-sharing sources of money from outside the jurisdiction generally used to finance a portion of the capital costs of a project. They generally are earmarked for only certain types of capital costs as typified by the EPA construction grants program and they may typically have conditions attached which will influence project selection and therefore socioeconomic impacts.	• EPA construction grants program for public wastewater treatment programs • Department of Agriculture cost-sharing grants program for local erosion projects • Department of Agriculture low interest loan program for public wastewater treatment programs	By subsidizing a percentage of capital costs, grants and loans will, of course, reduce project public expenditures in the recipient jurisdiction. Such cost-sharing approaches may also stimulate other significant impacts. Public expenditures may be increased to the extent that capital intensive projects, such as centralized public sewerage systems, are favored by cost-sharing grants. Grants for the ancillary capital costs necessary to the centralized system may not be available; thus total public expenditures may be increased for strategies elgible for cost-sharing grants and loans. As shown in Chapter 7, cost-sharing programs can influence the type of structural control for a strategy. As illustrated in Exhibit 2-3, a variety of impacts flow from the characteristics of specific structural controls. Cost-sharing programs may impose conditions, such as industrial pre-treatment requirements in the EPA construction grants program, that will stimulate socioeconomic impacts. Finally, cost-sharing programs may stipulate other financing mechanisms for the project, such as the industrial cost recovery program user charge system required by P.L.92-500. These requirements will affect the distribution of private cost incidence.
(5) General Operating Revenues	These funds, used sometimes for capital costs as well as operating costs and regulatory costs, may include a variety of "unearmarked" sources from miscellaneous fees, fines, and taxes. They may be used to fund unspecified capital projects or may be set aside in sinking funds and earmarked for specific purposes.	Current operating revenues are rarely used to fund major capital costs but may be used for smaller water quality capital costs, such as a municipal septage vehicle. When set aside in sinking funds, operating revenues may be used for larger capital projects, such as land purchases.	The use of general operating revenues obscure the "earned rewards" financing principle and distribute private incidence costs to both users and non-users of a strategy. Sinking funds, much like a private savings account, uses past revenues to fund current projects. This "pay-as-you-go" mechanism benefits future users in contrast with borrowing schemes which burden future users and residents of a jurisdiction.
(6) Customer Contributions	In this mechanism, potential customers of a project are required to provide capital funds or facilities to provide them with a service.	Industrial cost recovery, although temporarily suspended by the 1977 Clean Water Act and presently under further study, is a prime example of this technique. Developer dedications of stormwater detention facilities, open and collection sewers in new developments are other examples.	Industrial cost recovery schemes (They have been, however, temporarily suspended by the 1977 Clean Water Act) generally produce favorable impacts on public expenditures and mixed results as far as cost incidence to firms impacts. The retained revenue provision allows local communities to keep a portion of capital funds recovered from industry. (Continued on next page.)

Exhibit 2-4 (Continued)

Public Financing Mechanism	Definition	Uses/Examples	Impact Issues
(6) Customer Contributions (Continued)			This represents an additional subsidy for the local municipality above and beyond the federal grant to the community. In addition, the local municipality also benefits if economies of scale result from the inclusion of industrial capacity in the local wastewater treatment plant. While the ICR represents a cost incidence to affected firms, a tie-in to the municipal facility under certain conditions may be more cost favorable than an individual industrial treatment facility. Potential cost advantages for municipal tie-in to the industry include no interest payments on the industrial cost share and the benefits associated with economies of scale. The impacts of developer contributions are discussed more fully in Chapter 10, Private Individual Costs and Benefits. In general, these requirements reduce public expenditures by shifting costs to the developer who in turn will shift all or part of these costs to future homebuyers. This shifting of costs represents a private cost incidence to new homebuyers--both presently within and outside the community.
(7) User Charges	User charges are revenues derived from a user of a project and are based on actual or surrogate use of a system or strategy.	User charges are used to finance capital, operating, and regulatory costs and include wastewater system user charges, permit fees, and license fees.	User fees and charges are designed to maximize the "earned rewards" principle by charging users for services received. Most user charge systems, whether they are for operating costs or regulatory costs, rarely reflect actual user costs. User charge systems that adhere strictly to actual costs associated with a user may pose excessive cost incidence to firms and individuals. User charge systems designed to finance high fixed charges often stimulate expansion of a strategy to increase users and thus lower average user charges. In the case of sewers, this may stimulate growth-related land use impacts.
(8) Property Taxes	Property taxes represent a communitywide revenue source based on the assessed valuation of an individual's property.	Property taxes are used to finance capital, operating, and regulatory costs associated with water quality strategies. Since the 1977 Clean Water Act, property taxes may be used to fund operating costs of publicly-owned wastewater treatment systems in communities where residential properties comprise most of the system's flow.	Property taxes generally obscure the true costs of a water quality strategy to users by distributing cost incidence to individuals impacts to both users and non-users of a system. Non-users may not enjoy direct benefits of use but may enjoy "community benefits" that a water quality strategy may proffer.

Exhibit 2-4
(Continued)

Public Financing Mechanism	Definition	Uses/Examples	Impact Issues
(9) Special Assessments	Special assessments are revenues from properties that reflect the benefits of a water quality strategy accruing to the property. Front-footage or or area considerations are often used to determine the assessment amount.	Special assessments are used primarily to fund capital costs financed through General Obligation bonds and Special Assessment Bonds.	Like user charges, special assessments are intended to maximize the "earned rewards" principle, i.e., beneficiaries pay for benefits. This may represent a substantial cost incidence to individuals who are large landowners--both in terms of the direct assessment costs and the increased property tax assessments. In essence, the carrying costs for undeveloped land are substantially increased through this mechanism. When used to finance sanitary sewers, for example, special assessments on large undeveloped properties may stimulate land conversion and land use impacts.
(10) Expenditure Cuts in Other Public Services	This technique is merely a revenue transfer from other services.	• Use of bonding capacity to finance water quality strategy rather than other community capital projects • Increase in percentage of general revenues used to finance water quality strategy operating costs	The impact of this technique on other public services depends on whether the revenue transfer is done on a one-time basis to finance a capital cost for a water quality strategy or whether an on-going pattern of revenue erosion for other public services is established. By financing water quality strategies with this technique, the financial burden is distributed to the users of the other affected public services.

Example 2-1 which deals with a proposed sewage treatment facility in the hypothetical community of Smithville illustrates other relationships between direct and indirect impacts associated with water quality strategies. While this particular example does not pretend to capture all of the potential impacts and impact interactions that are associated with sewage treatment facilities, it does illustrate several relevant points about indirect impacts.

Relationship of Impacts

The likelihood of indirect impacts occurring is very dependent on the magnitude and likelihood of the preceding impact. This likelihood of occurrence should be distinguished from the strength of relationship that exists between impacts. For example, under the right conditions in an area, there is a very strong relationship between housing changes and population changes. On the other hand, the relationship between sensory impacts and land use changes is more tenuous. In essence, then, the likelihood and the magnitude of indirect impacts is dependent on these conditions: the likelihood of the preceding impact; and the context of the impact area. One of the implications of this dependency is that higher order impacts tend to be less certain because the number of variables affecting them increases with each link on the chain. Thus, attribution of higher order impacts to water quality strategies requires great care and judgement.

The strength of the relationship between impacts is perhaps one of the most influential factors in indirect impacts. Certain impacts will potentially always trigger other specific impacts. For example, there is strong correlation between impacts in the "land use-housing-population-public services" impact chain.

Quantification of Indirect Impacts

Clearly, the ability to quantify indirect impacts is directly related to the relative quantification of preceding impacts. For example, if in Example 2-1 illustrated above, 1,500 housing units are expected to be developed in the western part of town, then the quantification of population effects is fairly straightforward. If on the other hand, new housing starts in that area are expected to be "substantial", then it becomes more difficult to attach a quantified population estimate to the housing impact.

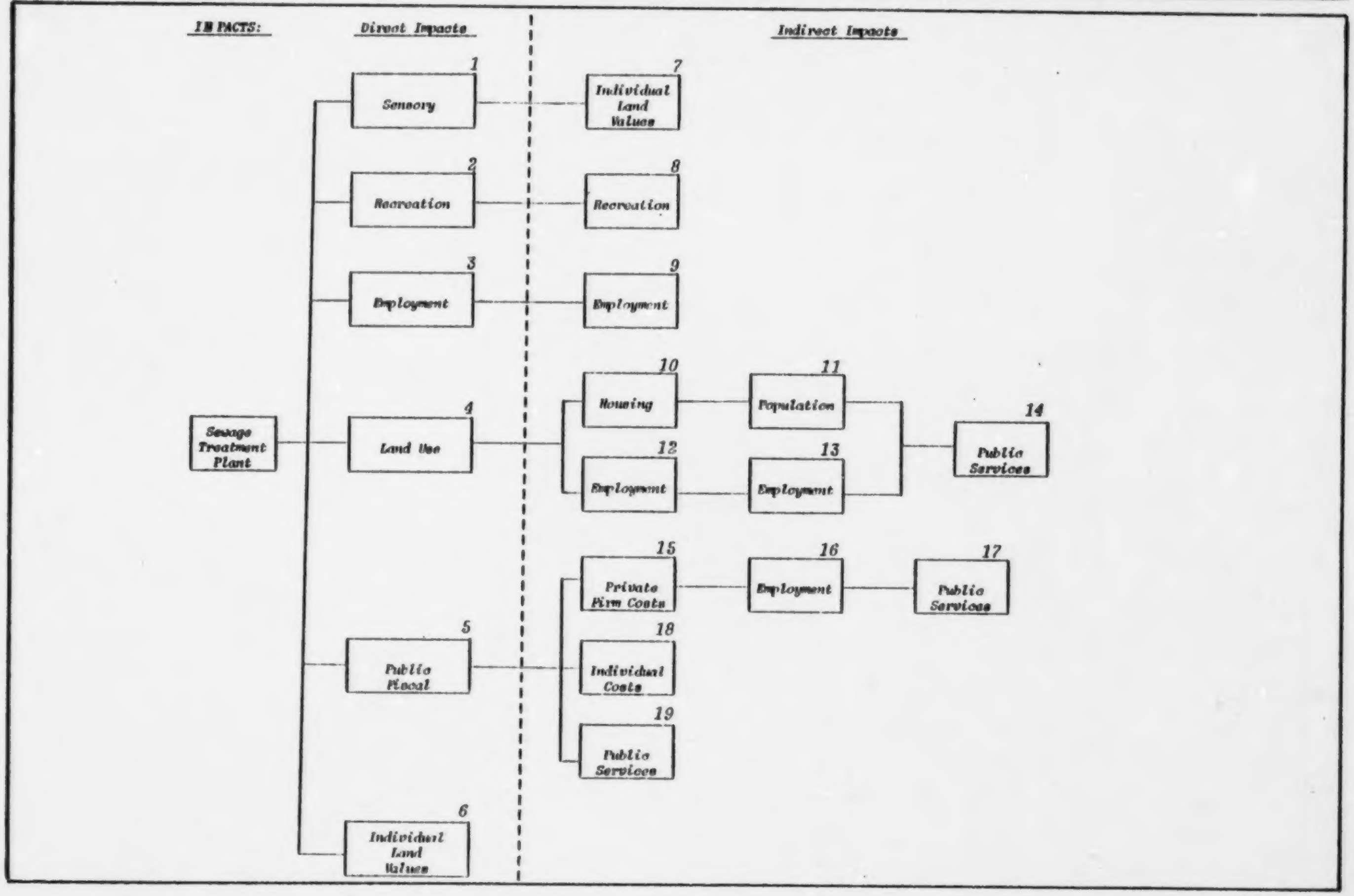
Cumulative Effects

The above example clearly demonstrates the need to carefully examine net effects. For example, the net effects on water supply may result in little or no change from the status quo. There are potential increases in water consumption demand associated with population and employment growth (impact 14). These may be more than offset, particularly in the short term, by the decreases in water supply (impact 17) associated with employment loss. Similarly, the loss of employment associated with the leather firms may be more than offset by the increase in employment around the highway interchange.

Example 2-1

Indirect Impacts Associated with a Sewage Treatment Facility in Smithville

Background: ***Smithville is a small bedroom community of 5,000 located along Interstate 24 about 20 miles south of Center City. Because of poor soils that limit development with on-site wastewater systems, the town is considering its first sewage treatment facility. About 2,000 of the town's residents will be served by the first phase of the project. Local capital costs for the project will be financed by long-term general obligation bonds which will be paid off by property taxes, benefit assessments, and user charges. Local capital costs will total $3 million dollars. The only two industries in town -- two leather tanning firms -- presently discharge to the North River. The proposed plan calls for them to discontinue their present direct discharges of tanning wastes and to pretreat their wastes and tie into the new advanced sewage treatment plant. Because of a shortage of sites along the North River the plant will be built in an area characterized by large-lot single-family homes.***



Example 2-1 (continued)

Impacts Associated with a Sewage Treatment Facility in Smithville

Direct Impacts	Indirect Impacts	
1. Sensory o Increased visual nuisances o Increased noise nuisances 2. Recreation o Loss of public access to boating and canoe launching area 3. Employment o Increase in construction related and operational employment associated with the plant 4. Land Use o Increase in developable residential land in southern part of town o Increase in developable commercial land around Interstate 24 highway interchange 5. Public Fiscal o Increase in capital and operational costs associated with public sewerage 6. Individual Land Values o Increases in property values of proposed sewered land	7. Individual Land Values o Decrease in land values in the area surrounding the treatment plant 8. Recreation o Increase in demand on other riverfront public boat and canoe areas 9. Employment o Increase in multiplier service-related employment 10. Housing o Increased number of housing units o Changes in single-family/multi-family mix in town o Increased rate of development 11. Population o Increased population o Increased rate of growth 12. Employment o Increase in commercial employment o Increase in construction employment 13. Employment o Increase in multiplier service-related employment	14. Public Services o Changes in public services demand 15. Private Firm Costs o Changes in wastewater costs and tax burdens for firms connected to municipal systems 16. Employment o Decreases in local manufacturing employment 17. Public Services o Change in water consumption demand 18. Individual Costs o Changes in wastewater costs and taxes 19. Public Services o Changes in proposed water supply facilities construction

CHAPTER 3
Impact Identification

3.1 INTRODUCTION

Impact identification is one of the most important steps in the overall socioeconomic assessment of water quality management strategies. The success of succeeding tasks--impact measurement, impact evaluation, and impact mitigation--will be dependent upon the adequacy of the impact identification step. Impact identification should serve the following purposes:

- Identify potential direct and indirect impact issues;
- Identify potential geographic areas affected;
- Identify potential group interests affected.

The identification of potential impact issues should be systematically done by the planning agency for each water quality strategy under consideration. In most water quality planning processes, impact identification is typically an ad hoc process. A few general impact categories are selected for use in the assessment and varying degrees of description are used in each of the categories to assess the impact of alternative strategies. This approach runs the risk of missing relevant impact issues altogether. The process needs to be systematic and able to consider a variety of impact issues. By initially being as inclusive as possible, there will be less chance of new impact issues emerging when the overall assessment process is nearing completion.

The spatial distribution of impacts is an important aspect of impact identification. By determining the political jurisdictions in which impacts are expected to occur, for example, the planning agency will be able to anticipate how to incorporate these areas into the planning process. Spatial incidence may include a variety of geographic areas. These may be neighborhoods within immediate sensory contact of a facility; it may be a waterfront area of a lake that is affected by development restrictions; it may include a watershed affected by stormwater runoff regulations; it may include an entire community affected by a septic system management program; or it may include an entire region that is directly affected by water quality standards. It is important to note that areas affected by water quality strategies do not just include areas for which a strategy is intended to apply. There may be important indirect or secondary effects on neighboring areas resulting from the application of a specific strategy. For example, the imposition of growth management controls in one community, may, under given circumstances, be instrumental in channelling new development to another community.

The incidence of impacts on particular groups is clearly an important dimension in socioeconomic assessment. This type of determination is one of the features that distinguishes socioeconomic assessment from mere cost-effectiveness analysis. This identification of impacted groups will also enable the planning agency to incorporate affected interests in the planning process. By including potentially affected interests throughout the planning process, there will be less likelihood of groups emerging at the end of the process and derailing implementation strategies. As in the case of spatial distribution effects, group or individual incidence may occur directly or indirectly. For example, specific property owners to be served by a proposed sewer will be directly affected in a variety of ways. They will bear user costs for the sewers; and they will incur, to some extent, increased property value benefits which, in turn, may be translated into higher property taxes. In communities where the lack of sewers serves as a major development constraint, non-sewered property owners will also be affected. Under certain conditions, those property owners may see their property values adversely affected by sewer service area decisions. Exhibit 3-1 presents a list of groups potentially affected by water quality strategies.

3.2 IMPACT IDENTIFICATION PROCEDURES

The following steps are recommended as procedures for systematically identifying potential socioeconomic impacts:

IMPACT IDENTIFICATION PROCEDURE

Step 1 Describe the alternative or proposed action

Step 2 Determine direct impact issues

Step 3 Determine direct impact incidence

Step 4 Determine indirect impact issues

Exhibit 3-1

MAJOR GROUPS POTENTIALLY AFFECTED BY WATER QUALITY STRATEGIES

SOCIOECONOMIC/DEMOGRAPHIC GROUPS

- Age groups
- Racial groups
- Income groups
  --Low
  --Moderate
  --High

ECONOMIC GROUPS

Industrial/Firms
--By Standard Industrial Classification Code Status
--"Wet" versus "Dry"
--Direct dischargers versus those connected to municipal treatment plant
--By employment size
--Water body dependent (marinas, tourism, hotels, fishing)
--Land development groups (real estate, developers, builders)
--Agricultural interests

Property Owners
--Adjacent to pollution control facilities
--Water adjacent properties
--Strategy-served properties versus non-served
--Owners of undeveloped land
--By assessed valuation
--By watershed
--By neighborhoods
--Seasonal

POLITICAL JURISDICTIONS

- Residents and political leaders of jurisdictions containing strategy
- Residents and political leaders of adjacent jurisdictions
- Residents and political leaders of regional/metropolitan area

OTHER INTEREST GROUPS

- Recreational boaters
- Recreational fishermen
- Other recreational groups (hunters, campers, swimmers, etc.)
- Area or interest-specific environmental groups

OTHER PUBLIC AGENCY OR GOVERNMENTAL GROUPS

- Federal
  --Other EPA--solid waste, air quality, drinking water, noise
  --Corps of Engineers
  --Department of Commerce (Economic Development Administration)
  --Department of Housing and Urban Development
  --Department of Interior (Bureau of Land Management, Fish and Wildlife Service)
  --Department of Energy
  --Department of Agriculture (Soil Conservation Service, Agricultural Stabilization and Conservation Service, Farmers Home Administration
  --Coastal Zone Management

- State
  --Water pollution
  --Water supply/Natural Resources
  --Environmental Management/Protection
  --Environmental Health/Health
  --Planning and Development
  --Coastal Zone Management
  --Department of Transportation

- Local
  --Water supply
  --Environmental Health and Sanitation
  --Wastewater
  --Planning/Development/Zoning
  --Public Works

Step 5   Determine indirect impact incidence

Step 6   Aggregate and display results

Step 1: Describe the alternative or proposed action.

Because of the wide range of detail and structure in alternatives, two approaches are recommended for describing the alternative: a summary approach shown in Example 3-1 and a more detailed approach shown in Example 3-2. Example 3-1 may be particularly appropriate when a number of alternative are quickly being generated and a rapid screening and evaluation is called for. For more detailed analysis, Example 3-2 illustrates the information that should be abstracted from the basic components of the alternative. Depending on the type of alternative, not all of these characteristics would have to be delineated. The worksheets have been completed as examples.

Step 2: Determine direct impact issues.

The basic method suggested for identifying potential direct socioeconomic issues is a check list approach. This method requires an implicit consideration of the alternatives or water quality action while examining a specific list of potential impact issues. The impact checklist, shown in Example 3-3, merely requires a "yes-no" type of consideration and can be completed relatively quickly. The list of issues presented in Example 3-3 is merely suggested and is not intended to be exhaustive.

In considering which issues to include in a checklist for a specific alternative, the water quality planner should consult Appendix A which contains potential socioeconomic issues for the thirteen water quality contral categories of interest in this guidebook. The sections of Appendix A that should be consulted are:

A-2 On-Site Wastewater Systems

A-3 Centralized Wastewater Systems

A-4 Residuals Management

A-5 Industrial Wastewater Controls

A-6 Infiltration-Inflow and Combined Sewer Controls

A-7 Domestic Water Conservation

A-8 Urban Stormwater Source Controls

A-9 Urban Stormwater Flow Attenuation Controls

A-10 Urban Stormwater Storage/Treatment Facilities

✓ 3-1

Example 3-1

WORKSHEET WS-1: Summary of Water Quality Alternative

Name of alternative: Water Conservation Alternative A: Retrofitting existing toilets

Purpose: To reduce water consumption and wastewater flows in public sewerage system

Description:

Type of structural control/management practice: Distribution of plastic bottles or specially-fired bricks for toilets

Implementation measure(s):
- Free distribution to homeowners & building owners
- City ordinance requiring retrofitting of existing buildings within 1 year

Institutional arrangements:

Public: Public financing of materials and distribution

Private: Installing of materials by homeowners with instruction sheet

Location/area(s) of coverage: (use map if appropriate) Center city -- 7,500 buildings; estimated 30,000 toilets with water closets

Costs:

	Public	*Private*
Capital	$105,000	----
O&M	$ 70,000	----
Regulatory	$ 15,000	----

Public Financing:
- Water and sewer revenues for capital and regulatory costs
- CETA program for one-year administration

Example 3-2

WORKSHEET WS-2: Description of Water Quality Alternative Components

Name of Alternative: Smithville Sewerage Alternative A

Structural Control Features/ Management Practices

Type of Control/Practice: Centralized sewage treatment facility and collection

Physical Characteristics: (size, height, form, etc.) Activated sludge treatment plant; 500 yards from nearest houses; tallest building--30 feet

Capacity: Average day demands--.4 MGD;

Resource Inputs: (water or land) 60 acres of presently vacant land adjacent to North River including boat launching site

By-Products: Sludge (to be buried in site); increased development capacity for proposed service area

Construction Activities:

Nuisance aspects: Truck traffic with materials and equipment

Physical alterations:

Excavations: Collection system

Operating Characteristics:

Nuisance aspects: Septage truck traffic

Physical alterations: Occasional odor problems

Implementation Measures

Regualtory: EPA permit has mandated sizing of facility and location of service area; EPA permits mandate tie-in of existing industries to plant; sewer use ordinance will mandate industrial pre-treatment

Example 3-2 (continued)

Economic: EPA and State Capital Cost Sharing to Smithville for treatment facility and interceptor lines.

Education:

Enforcement: Sewer use ordinance and permits includes fines for potential non-compliance

Institutional Arrangements

Management Functions	*Private*	*Public*	*Public Financing*
Regulatory		Smithville Sewer Dept.	User Fees
Economic			
Enforcement		Smithville Sewer Dept.	User Fees
Education			
Planning		Smithville Sewer Dept./ Consultant	EPA/State grant; General obligation bonds
Design		Smithville Sewer Dept./ Consultant	EPA/State grant; General obligation bonds; Benefit Assessments
Construction	Industrial firms requiring pretreatment	Smithville Sewer Dept./ Contractor	EPA/State grant; General obligation bonds; Benefit Assessments
Operation/ Maintenance	Industrial firms requiring pretreatment	Smithville Sewer Dept.	User Fees

Reduced 90%

3-3

Example 3-3

WORKSHEET WS-3: Impact Identification Checklist: Direct Impacts

Alternative: Water Conservation Alternative A

IMPACT ISSUES	
1.0 PUBLIC FISCAL	
1.1 Changes in capital and operating costs associated with public water pollution control facilities	X
1.2 Changes in administrative and regulatory costs	X
1.3 Changes in revenues for public water pollution control facilities	___
1.4 Changes in other public service revenues/expenditures	X
1.5 Changes in tax base	___
1.6 Other	___
2.0 PRIVATE INDIVIDUAL COSTS/ BENEFITS	
2.1 Changes in water quality compliance costs: charges and fees	X
2.2 Changes in water quality compliance costs: property taxes	___
2.3 Changes in other public service costs	X
2.4 Changes in property values	___
2.5 Other	___
3.0 PRIVATE FIRM COSTS	
3.1 Changes in water quality compliance costs: capital and operations	___
3.2 Changes in water quality compliance costs: administrative	___
3.3 Changes in water quality compliance costs: charges and fees	X
3.4 Changes in water quality compliance costs: property taxes	___
3.5 Changes in other public service costs	X
3.6 Changes in property values	___
3.7 Other	___
4.0 EMPLOYMENT/ECONOMIC GROWTH	___
4.1 Changes in facility-related construction employment	___
4.2 Changes in public employment for water pollution control facilities	___
4.3 Changes in employment for firms affected by water pollution control compliance costs	___

IMPACT ISSUES	
4.4 Changes in employment/# of firms due to accelerator effects	___
4.5 Changes in employment/# of firms due to multiplier effects	___
4.6 Other	___
5.0 LAND USE/HOUSING/POPULATION	
5.1 Changes in types of new development	___
5.2 Changes in new development location	___
5.3 Changes in new development density	___
5.4 Changes in rate of new development	___
5.5 Changes in amount of new development	___
5.6 Changes in amount of developable land	___
5.7 Pre-emption of scarce or valued land	___
5.8 Changes in land costs	___
5.9 Changes in housing opportunity: amount of units	___
5.10 Changes in housing opportunity: type of housing	___
5.11 Changes in housing opportunity: location	___
5.12 Changes in housing opportunity: housing costs	___
5.13 Changes in population pattern: rate of development	___
5.14 Changes in population pattern: amount	___
5.15 Changes in population pattern: location	___
5.16 Changes in population pattern: type	___
5.17 Changes in population pattern: growth rate	___
5.18 Other	___
6.0 OTHER PUBLIC SERVICES	
6.1 Changes in demand for: water supply ____________	X

IMPACT ISSUES	
6.2 Changes in capacity of: ____________ ____________	___
6.3 Changes in perfomance/quality of: ____________ ____________	
6.4 Changes in the distribution of: ____________ ____________	___
6.5 Other	___
7.0 RECREATIONAL OPPORTUNITIES	
7.1 Changes in demand for water-based/land-based opportunities	___
7.2 Changes in capacity of water-based/land-based activities	___
7.3 Changes in performance/quality of water-based/land-based activities	___
7.4 Changes in the distribution of water-based/land-based activities	___
7.5 Other	___
8.0 HISTORIC RESOURCES	
8.1 Changes in physical accessibility to historic and archeological resources	___
8.2 Alteration/deplacement of historical and archeological resources	___
8.3 Other	___
9.0 SENSORY	
9.1 Changes in visual nuisances	___
9.2 Changes in visual conflict	___
9.3 Visual changes in natural elements	___
9.4 Changes in visual identity	___
9.5 Changes in views and vistas	___
9.6 Changes in the type, frequency, magnitude of noise nuisances	___
9.7 Changes in the type, frequency, and severity of odor nuisances	___
10.0 PUBLIC HEALTH/SAFETY	
10.1 Changes in facility-related accidents	___
10.2 Changes in public health risks associated with the operation of water pollution control facilities	___
10.3 Changes in flood potential	___

34

A-11 Urban Soil Erosion Controls

A-12 Agricultural Source Controls

A-13 Growth Management Controls

A-14 Hydrographic Modifications

This appendix is particularly helpful in completing the checklist since it relates impact issues to water quality control strategy characteristics.

Step 3: Determine direct impact incidence

This step requires that potential groups and areas be identified for each direct impact issue identified in Step 2. The detail of the proposed alternative or action will affect the ability to identify incidence. As seen in Examples 3-1 and 3-2, a certain amount of information for affected areas and groups will be available in the description of the alternative.

The suggested approach for identifying both affected groups and areas is to use a checklist. The major categories of potentially-affected groups includes at its broadest level: users, compliants, beneficiaries, those adversely affected, those who pay, and those who manage or administer the proposed actions. Not all of these groups may be applicable for a particular strategy. The generic groups listed in Exhibit 3-1 should be used as a general checklist. Planning agencies may wish to develop a checklist with specific groups relevant to their study area. It should also be noted that while this guidebook is not specifically addressing water quality benefits, planning agencies may wish to include groups that are obviously affected by water quality. These include boat owners, fishermen, tourists, and the like.

The checklist for potentially affected areas should be developed according to local conditions using the following general categories: service areas; political jurisdictions; special geographic areas, such as watersheds, lakeshore areas, neighborhood, geographic sections of a community, regions, economic and housing market areas, and areas defined by natural or environmentally-sensitive conditions.

Step 4: Determine indirect impact issues.

Unlike Step 1 where the planning agency is concerned with the impacts that directly occur from the characteristics, this step requires an identification of the impacts that are stimulated by the direct impacts themselves. The purpose of this step is to not only identify first-order impacts but higher-order impacts as well. It is difficult to prescribe what order of indirect impacts the planning agency should attempt to identify. The planning agency should not limit itself to an arbitrary number, say 4th order impacts. Such arbtirariness may fail to identify important indirect impacts or it may identify potential indirect impacts of no importance. As discussed in Chapter 4, several factors will influence the likelihood of indirect impacts occurring, including the following: likelihood of the preceding impact, the magnitude of the preceding impact, the strength of relationship between impact categories, and the context within which impacts are occurring. Because only very tentative indirect impacts can be identified at this point in the assessment process, a great deal of effort should not be exercised in identifying indirect impacts.

The recommended procedure is to take the identified potential direct impacts and identify the complete chain of impacts potentially associated with that direct impact. The checklist of impact issues used in Example 3-3 should be used to identify each succeeding potential impact in the impact chain. In carrying out this procedure, the indirect impacts identified in Appendix A should be consulted. The indirect impacts will give the user of this guidebook an indication of potential impact chains for different water quality controls.

Step 5: Determine indirect impact incidence.

This step requires that potential groups and areas be identified for each indirect impact issue identified in Step 4. Similar to Step 3, a checklist approach is suggested.

Step 6: Aggregate and display information

This is simply a mechanical step in which information is summarized as shown in Example 3-4.

Example 3-4

Potential Impact Incidence for Smithville Sewage Treatment Facility

Direct Impact Issues	Groups Affected	Areas Affected
1. Sensory ● Increased visual nuisances ● Increased noise nuisances	Property owners	Pleasant Valley neighborhood adjacent to plant
2. Recreation ● Loss of public access to boating and canoe launching area	Boat and canoe owners	Smithville
3. Employment ● Increase in construction-related employment associated with the plant	Construction industry	Center city metropolitan area
● Increase in operational employment with the plant	*	*
4. Land Use ● Increase in developable residential land	Property owner	Proposed sewer service area, particularly vacant areas
● Increase in developable commercial land	Property owners	Proposed sewer service area, particularly Interstate II interchange area
5. Public Fiscal ● Increases in capital and operational costs associated with public sewerage	*	Smithville
6. Individual Land Value ● Increase in property value	Property owners	Proposed sewer service area

3-4

Example 3-4 (continued)

Potential Impact Incidence for Smithville Sewage Treatment Facility

Indirect Impact Issues	Groups Affected	Areas Affected
7. *Individual Land Values*		
● *Decrease in land values*	*Property owners*	*Pleasant Valley neighborhood adjacent to plant*
8. *Recreation*		
● *Increase in demand for other public boat and canoe areas*	*Owners and users of other public boat and canoe areas*	*Other North River facilities*
9. *Employment*		
● *Increase in multiplier service-related employment*	*Metropolitan area labor force*	*Metropolitan area*
10. *Housing*		
● *Increased number of housing units*	*New homebuyers; realtors; developers; builders*	*Metropolitan area*
● *Changes in housing mix*	*	*
● *Increase rate of development*	*New homebuyers; realtors; developers; builders*	*Metropolitan area*

3-4

Example 3-4 (continued)

Potential Impact Incidence for Smithville Sewage Trestment Facility

Indirect Impact Issues	Groups Affected	Areas Affected
11. Population ● Increased population ● Increased rate of growth	New homebuyers	Smithville
12. Employment ● Increase in commercial employment ● Increase in construction employment	Metropolitan area labor force Construction industry	Metropolitan area Metropolitan area
13. Employment ● Increase in multiplier employment	Metropolitan area labor force	Metropolitan area
14. Public Services ● Changes in public services demand	Public services users	Smithville
15. Private Firm Costs ● Changes in wastewater costs	Firms tied into sewerage system, primarily local leather firms	Smithville
16. Employment ● Decreases in leather-related employment	Employees of local leather tanning firms	Smithville
17. Public Services ● Changes in water consumption demand	Leather tanning firms; water supply users	Smithville

3-4

Example 3-4 (continued)

Potential Impact Incidence for Smithville Sewage Treatment Facility: Direct Impacts

Indirect Impact Issues	*Groups Affected*	*Areas Affected*
18. *Individual Costs* ● *Changes in wastewater costs and taxes*	*Users; all property owners*	*Sewer service area users; Smithville*
19. *Public Services* ● *Changes in water supply capacity*	*Water supply users*	*Smithville*

**Indicates not discernible or not an issue.*

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CHAPTER 4
Impact Measurement

4.1 INTRODUCTION

The Impact Measurement step represents the core activity of the socioeconomic impact assessment process. Because of the potentially large number of impacts that are candidates to be measured, the planning agency will have to consider:

- What impact issues should be measured?
- What impact indicators should be used?
- How should the impacts be measured?

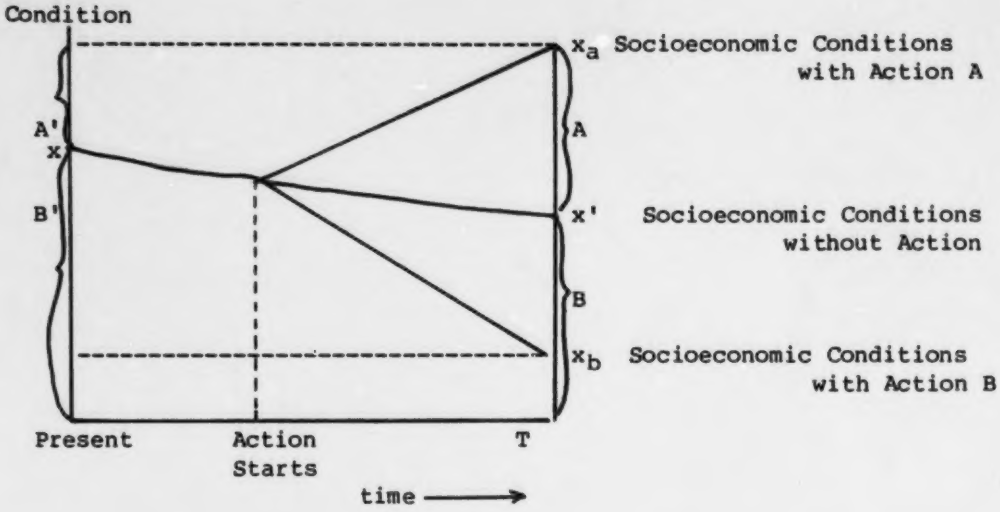
This chapter provides general guidance in making impact measurement decisions in the socioeconomic assessment process. The emphasis in the chapter is on definitions, concepts, and guidance. Specific impact measurement techniques for the ten (10) impact categories used in this guidebook are presented and discussed in Part 2.

4.2 BASIC IMPACT MEASUREMENTS CONCEPTS

Impact Definition

Impact measurement represents an attempt to measure the effects or changes brought about by an action or policy. What represents a "change" or an "effect"? The following figure provides an illustration of impact definition.

41



Action A represents a comprehensive public sewerage program utilizing a centralized land application treatment plant. Action B is more limited public sewerage program with three (3) small plants. There are less economies of scale associated with Action B and costs to firms that tie into these plants will be higher than Action A. If neither Action A or B is implemented, manufacturing employment levels in the community are projected to fall to x' or 900; under Action A they are expected to increase x_a 1600; under Action B they are expected to fall to x_b or 600. What are the impacts of Action A and Action B?

Several conditions are portrayed in this figure:

- Present - Existing socioeconomic conditions
- Future Without - Socioeconomic conditions in the future without the proposed Action A or B. Included in this scenario are all other actions that alter present conditions.
- Future With - Socioeconomic conditions in the future with either Action A or Action B. These scenarios also include other actions that affect present conditions.

In the case where Action A is proposed, the impact of Action A is represented by A, or the difference between the "future with Action A" and the "future without." Similarly, in terms of Action B, the impact of Action B is represented by B. It is important to distinguish B from B'. The difference B represents is a net impact while B' represents a gross impact. B' is the difference between the "future with Action B" and the "present conditions." When B' is measured, there is no attempt to forecast or predict the affect of other variables on the present condition.

Using real numbers will help to clarify the difference between B and B'. Let the socioeconomic condition of interest be manufacturing employment in a local community. At the present time, employment x totals 1200 people.

Using a "net impact" description, the impact of Action A on manufacturing employment is equal to the difference between x_a and x' (1600-900) or +700 jobs. The impact of Action B is equal to the difference between x_b and x' (600-900) or -300 jobs. The difference between A and B is 1000 jobs. Using a "gross impacts" approach, the impact of Action A on manufacturing employment is equal to the difference between x_a and x (1600-1200) or -600 jobs. In this particular example, the net impacts approach tends to make Action A look more favorable than under the gross impacts method since the impact amount or magnitude is 700 jobs versus 400 jobs. Conversely, the net impacts approach understates the magnitude of change for Action B compared to the gross impacts method. Note that the difference between A or B, however, under both approaches is the same, i.e., 1000 jobs.

While the net impact approach is the more correct methodological approach, it may be appropriate to use the gross impact method. In particular, where the primary emphasis of the impact assessment process is to chose a more "favorable" alternative than another, either approach produces the same absolute impact difference between alternatives. Therefore, the gross impact method is an acceptable approach if the purpose of the assessment is to highlight absolute differences among alternatives. The planning agency, however, should attempt to minimize mixing both approaches in measuring impacts of alternatives. Whatever impact measurement approach is used, the planning agency should clearly indicate the assumptions and the limitations associated with each approach.

Types of Measurement

In its broadest terms, impact measurement attempts to translate subjective issues into measureable terms. There are certainly different ways of accomplishing this, however, and an understanding of the basic types of measurement is important in both the Impact Measurement and the Impact Evaluation activity. Impacts may be expressed by different levels of measurement acording to various scales. The impacts may be described in terms of monetary, other quantitative, or qualitative measures. Depending on the type of measurement, various mathematical comparisons and manipulations may or may not be valid in the Impact Evaluation activity. Four generic types or scales of measurement are discussed below:

> Categorical scales: These scales place impacts into discrete categories but one generally cannot say whether one category is "better" than another. In this classification type of measurement, it is possible, however, to design categories such that the information can be used to screeen out alternatives in the later evaluation steps. For example, one can categorize an impact as

"short-term" or "long-term".

Ordinal scales: These scales imply a ranking measurement. For example, ordinal measurements for one impact across four alternatives may be expressed along the following five categories: extremely beneficial, moderately beneficial, neutral, moderately adverse, extremely adverse. Arbitrary numerical measures may also be employed to correspond to the above, such as +2, +1, 0, -1, and -2. One cannot assume that the difference in magnitude involved in moving from a measurement of 0 to a measurement of +1 is equal to the difference between impact levels +1 and +2.

Interval scales: These scales provide equal intervals betwen impact levels and indicate the differences or distances of impact levels from some arbitrary origin. Interval scales provide a means of measuring more precisely than ordinal scales the dimensions of an impact. Since a continuous scale is used, relative differences between impact levels may be compared. For example, if alternatives for a particular impact category are measured on an arbitrary 10-100 scale, with 10 representing the lowest impact level and 100 indicating the highest level, then one can actually say how much better a particular alternative is compared to another. If four alternatives, A, B, C, and D, measure 100, 80, 60, and 50 respectively, then the difference between A and B is the same as the difference between B and C. The mathematical operations of addition and substraction are valid with interval scales along with multiplication or division by a non-negative constant.

Ratio scales: These scales like interval scales provide equal intervals between impact levels, but unlike interval scales, ratio scales use a non-arbitrary zero point. Using a ratio scale, impacts can be expressed in dollar terms or in natural physical units, such as length, weight, time, changes in air pollution levels, or changes in employment. Multiplication and division by interval or higher-order variables is valid, as are the operations of addition and subtraction. Thus, if a household cost for sewage treatment is $150/year, then it is twice as expensive as household costs totalling $75/year.

In general, it is desirable to measure impacts on the highest order scale that is possible. Measurement, no matter what scale used, inherently involves some degree of abstraction. Ratio scales obviously involve less abstraction than ordinal scales. It will be impossible, however, to use ratio scales for all socioeconomic impacts. Many impacts categories, such as visual quality, can only be qualitatively defined. In these cases the water quality planner simply has to resort to lower-order measurement scales to adequately describe impact levels. For some impact categories that are normally described in qualitative terms, it may be possible to employ surrogates that enable the use of higher order measurement scales. For example, it may be possible to use measures of crowdedness and accessibility as surrogate measures for the quality of recreational experience.

Example 4-1 illustrates different type of measures for selected impacts associated with sewage treatment plant. The impacts are drawn from those in Example 2-1.

Impact Measurement Dimensions

While not explicitly stated, discussion on impact measurement has focused primarily on the magnitude aspect of impacts. Clearly, impact magntitude is a major dimension of impact measurement. There are, however, other aspects that may be considered in impact measurement. The following summarizes the most important dimensions:

> Magnitude: This aspect is concerned with the amount or size of the impact and is synonomous with the net impact or gross impact discussed above.
>
> Direction: This aspect deals with the adverse or beneficial nature of an impact. Thus, if the impact indicator is change in employment levels, direction might be indicated as -300 jobs, for example, or +700 jobs. Thus, it is also possible to indicate direction within an impact indicator. For example, in the above example, the impact indicator could have been expressed as "loss of employment" or "increase in employment."
>
> Timing: This aspect refers to the occurrence of the impact and may refer to different periods or times in the future. For example, it may be important to note for some impacts that the impact will not take place until 5 years from now. This is particularly important in projects, such as sewage treatment plants, that may take 5-10 years or more to plan, design, and build. In this particular case, it is very possible that conditions will alter the magnitude of the impact before the impact is scheduled to occur.
>
> Duration: Complementing the above concept is the issue of impact duration. A traditional classification of this aspect is "short-term" and "long-term." This dimension is particularly important where the impact magnitude is large. For example, the construction of a sewage treatment plant may stimulate 300 new construction jobs, but the impact may only be for a short-term period. Similarly, on the negative sde, a sewage treatment plant may result in visual and noise nuisances due to construction-related traffic, but the impacts will be of a limited duration.
>
> Incidence: As discussed in Chapter 3, an important dimension of impact assessment is group and geographic incidence. Measurement cannot really occur in a vacuum. The magntitude and direction of an impact will vary by geographic area and by group. Using the construction employment example above, the 300 new jobs have rela-

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Example 4-1

SELECTED IMPACTS ASSOCIATED WITH PROPOSED SMITHVILLE SEWAGE TREATMENT FACILITY

Impact Indicator	Measurement	Type of Measure
X_1 Visual Nuisances	Acceptable	Categorical
X_2 Noise Nuisances	Exceeds 45 decibels more than 8 hours per 24 hours	Interval
X_3 Loss of public boat launching areas	Two (2) sites pre-empted	Ratio
X_4 Construction-related employment	+300 new temporary jobs	Ratio
X_5 Developable Residential land	1,500 acres opened up for development	Ratio
X_6 Public Fiscal Cost	$169,000 annual debt service costs	Ratio
X_7 Residential land values for Southwest sewer service area	Moderate increases	Ordinal

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tively little meaning unless the impact area is defined. The 300 new jobs may represnt a major impact in a rural community but may have virtually no significance if the impact area under consideration is a large region.

While all the above measurement dimensions are relatively easy to comprehend, the two temporal aspects -- duration and timing -- deserve some additional assessment. The selection of a time frame for impact measurement will affect all of the other measurement dimensions. Clearly, from some water quality projects, the impacts after 5 years will be different than those after 15 or 20 years. Example 4-2 illustrates the temporal variations possible with socioeconomic impacts.

As seen in Example 4-2, there may be considerable variation in the occurrence and in the duration of socioeconomic impacts for any particular action. Some impacts, such as the noise and visual nuisances, are temporary in nature; some impacts, such as debt service costs, are long-term; while others, such as, residential values, may be relatively permanent in nature. For water quality alternatives involving construction, it will not be unusual to have short-term effects related to the construction activities.

One of the implications of varying time streams for socioeconomic impacts is that the selection of a time-frame for the impact assessment will have a significant influence on the types and magnitude of impacts captured in the impact analysis. A relatively short-term time-frame of, say, 10 years may not capture all of the impacts from a project.

4.3 IMPACT MEASUREMENT PROCEDURES

The following steps are recommended as general procedures for the Impact Measurement activity:

Step 1 Perform Scoping Analysis
Step 2 Determine Measurement Approach
Step 3 Determine Baseline Conditions
Step 4 Perform Impact Measurement
Step 5 Present and Display Impacts

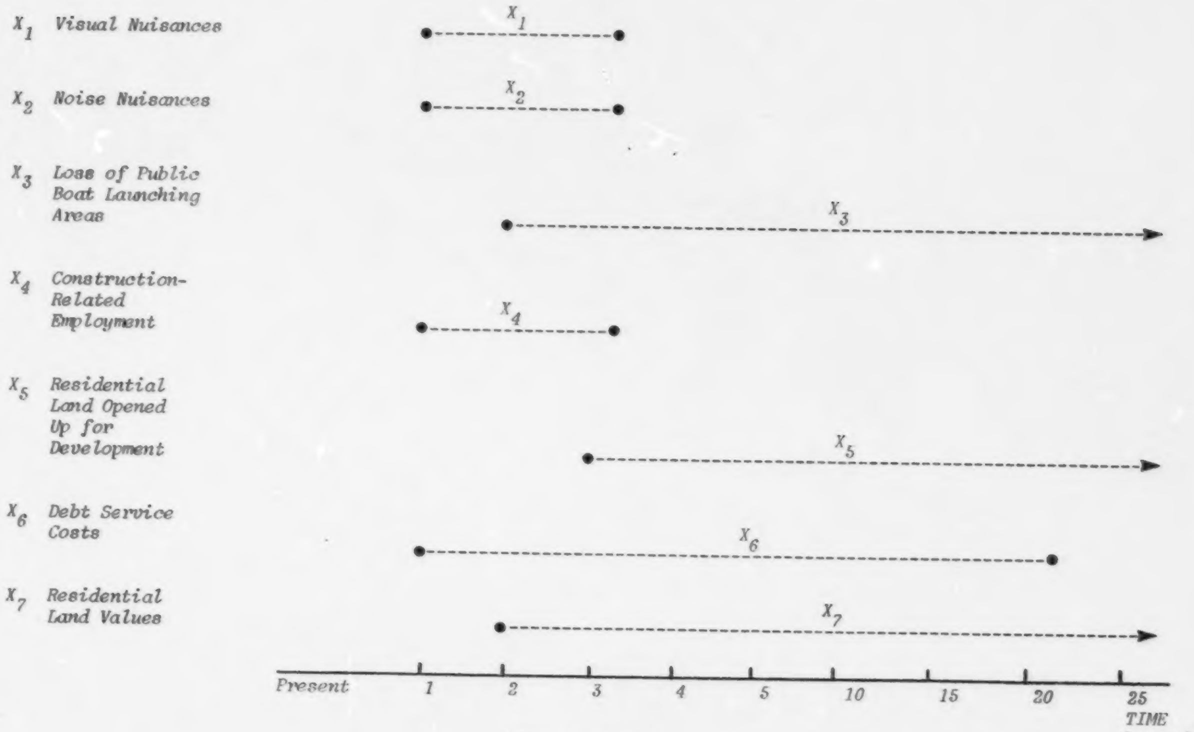
Step 1: Perform Scoping Analysis

The essential issue addressed in this step is: Does the impact issue appear to be an impact and thus warrant further consideration?

Answering this question involves a verification of the potential impacts identified in the Impact Identification module. Up to this point, identified impacts only potential impacts -- based primarily on the attributes or characteristics of the proposed alternatives. In this step the context or the setting for the propoed action is considered. The analysis should attempt to determine whether conditions are ripe for the potential impact to occur. Types of key conditions to consider for each impact category are

Example 4-2

Temporal Dimensions of Socioeconomic Impacts for Smithville Sewage Treatment Facility



(Not to Scale)

discussed in Part 2. The results of the scoping analysis may be presented as shown in Example 4-3.

It should also be emphazised that direct impacts are screened first. If a direct impact issue falls out using the key conditions test, then the need to screen for the indirect impact issues related to the direct impact is not required.

Step 2: Determine Measurement Approach

Several issues are addressed in this step:

- What level of analysis should be applied to the impact?
- What technique should be used to measure the impact?
- What impact indicator should be used to measure the impact?
- What geographic area and time frame is most appropriate?

In considering the desirable level of analysis, the planning agency should determine what impact issues are most important or significant. Significant impact issues may be defined in several ways and thus the planning agency should consider incorporating public participation in this decision. For example, the selection of significant impact issues may be judged by the following criteria:

- Impact issue is perceived by the public-at-large as important;
- Considerable controversy has surrounded this issue in previous occasions;
- A particular group or area that will be potentially affected requires special attention;
- The magnitude of the impact is expected to be severe;
- The proposed action or project is large in scope;
- The proposed action or project is precedent-setting in nature.

Ideally, those impacts that are considered the most important would be given the most attention in terms of measurement approaches. More resources would be devoted to those issues that are of the most concern. This decision, however, will in fact be dependent on the available impact measurement methodologies for that impact issue. As discussed in Part 2, impact measurement approaches vary from intuitive judgements and desk-top analysis to data intensive models requiring computer analysis. For some important impact issues, the more sophisiticated measurement approaches may be simply beyond the means of a planning agency's resources. The methodology may require a vast amount of data or it may involve a model that is not completely understood by the planning agency. In general, the following factors should be considered in choosing a methodology for measuring impacts:

- Level of measurement requirements
- Confidence in measurement approach
- Comprehensibility to user and public
- Resource requirements (time, cost, staff)

EXAMPLE 4-3

IMPACT ISSUES SCREENING RESULTS

POTENTIAL IMPACT ISSUES	SCREENING RESULTS		
	Probability of Occurence	Consider for Measurement	Comments
X_1 Increased visual nuisances	L	No	Conditions don't indicate impact.
X_2 Increased noise nuisances	L	No	Same as above
X_3 Loss of public access to boat and canoe launching area	H	No	
X_4 Increase in construction-related employment	H	Yes	
X_5 Increase in operational employment associated with plant	H	No	Expected to be too minimal to be of concern
X_6 Increase in developable residential land	H	Yes	
X_7 Increase in developable commercial land	H	Yes	
X_8 Increase in public sewerage capital and operational costs	H	Yes	
X_9 Increase in property values	M	Yes	
X_{10} Decrease in land values	L	No	Stimulating impact issues, X_1, and X_2, not impacts
X_{11} Increase in demand for other public boat and canoe launching areas	H	Yes	
X_{12} Increase in multiplier service related employment	L	No	Most construction workers will commute to construction job
X_{13} Increase in number of housing units	H	Yes	
X_{14} Changes in single-family/multi-family mix in town	L	No	New development is likely to be single-family
X_{15} Increased rate of development	M	No	Other areas in region are expected to absorb new development
X_{16} Increase in population	H	Yes	
X_{17} Increase rate of growth	M	No	See X_{15}
X_{18} Increase in commercial employment	H	Yes	
X_{19} Increase in construction employment	H	Yes	
X_{20} Increase in multiplier service-related employment	H	Yes	
X_{21} Change in public service demand	H	Yes	
X_{22} Change in wastewater costs and tax burdens for firms	H	Yes	
X_{23} Decrease in local manufacturing employment	M	Yes	
X_{24} Change in water consumption demand	M	No	Affected firms consumption is small compared to overall community use.
X_{25} Change in individual wastewater costs and taxes	H	Yes	
X_{26} Change in proposed water supply facilities construction	M M	No	Financing of new water storage tanks not expected to be affected

(L=low: M=Medium: H=high)

In order to balance the needs of desired measurement with available skills, time constraints, and costs, it may be necessary to go through several iterations of matching measurement techniques with impact issues.

Closely tied to the selection of mesurement techniques and the level of analysis is the selection of impact indicators. Impact indicators are measures uesd to describe the impact. A variety of impact indicators are presented for each impact category in Part 2. In initially considering the selection of impact indicators, the following considerations are appropriate:

- Impact indicators should relate to readily identifiable or familar concerns as much as possible. For example, aggregate costs of a project are more difficult to relate to than per household costs or changes in the property tax rate. This factor essentially calls for a focus on end impacts, where possible, rather than intermediate ones. This factor also recognizes the desirablilty of using indicators that are traditionally used, such as the unemployment rate, dwelling units/acre, and average daily traffic.

- Legal or mandatory requirements should be met. Federal, state, or local requirements may spell out certain concerns to be evaluated for certain projects. For example, EPA regulations for wastewater treatment plants call for per household costs for wastewater projects to be indicated.

- Indicators should be understandable. Impact indicators represent the attributes of a proposed action in the evaluation of alternatives. If they are complex and not easily understood by the public, then the evaluation task may be rather difficult. Abstract indexes or indicators involving technical jargon should be avoided where possible.

- Where necessary, use surrogate or proxy indicators. For many impact issues of a qualitative nature, it will not be possible to directly estimate the impact. In these cases, surrogate indicators may be appropriate if they are not too obtuse and are uesd with care and explained in footnotes. An example of a traditional indicator used for school crowdedness is the teacher/pupil ratio.

Finally, this step should delineate the time frame and geographic area for analysis. It is generally easy to estimate most impacts during the short-term and becomes exceedingly more speculative as the time period extends out beyond 10 years. Generally, the impact period used in water quality impact assessment is 20 years. This time period appears to be based on reasons of convenience -- many local and state socioeconomic projections use a twenty-year time period. While the 20-year time period is a reasonable compromise to use, it should be emphasized that impacts of a short and longer duration may occur. For example, some water quality projects may be financed with 30-year bonds. Fiscal and individual cost impacts, then, will be in place for a 30-year period. Some construction-related effects, on the other hand, such as visual and noise nuisances, will be short-term in nature and should be noted.

As noted in Section 4.2, the geographic incidence of socioeconomic impacts will vary by type of impact. Preliminary indications of geographic incidence have been presumably noted in Step 1 and they should be refined where needed in the actual measurement of impacts in Step 3. In Step 2, the planning agency should place some boundaries in the analysis. This will inevitably be a process involving compromises. The following factors should be considered in defining areas for analysis:

- Expectation of impact -- The initial area estimated in identifying impacts and possibly modified by the Step 1 scoping analysis can be used as an initial area. It may be possible, based on local knowledge, to estimate which areas will be most affected by the impact. Thus, areas where the impact incidence is expected to be minor may be eliminated for consideration.

- Existing data collection units -- Because of the difficulties often encountered in aggregating and disaggregating data from existing data collecton units, it is more often most practical to use existing data collection units as the area of analysis. These may include political jurisdictions, service areas, and market areas.

- Methodology requirements -- While not generally desireable, it may be practicable to define the impact area of analysis to be congruent with the areal limitations of a particular impact measurement methodology. This obviously has to be done with caution. If a potential methodology has areal capabilities that are simply incompatible with the area of expected impact, then it may be necessary to drop the methodology for consideration rather than to attempt to obscure impact measurement results with an inappropriate methodology.

It may be necessary to go into the actual measurement step with a tentative impact area which may be modified once the data collection and estimation activities begin.

Step 3: Determine Baseline Conditions

This step is concerned with developing a profile of existing conditions for each of the impact issues being considered for impact measurement. Whether the impact measurement task uses a "net impact" or a "gross impact" approach, as discussed in Section 4.2, a profile of existing conditions will be required.

In establishing the baseline conditions, the planner is primarily interested in the existing conditions for those impact indicators that des-

52

be in place for a 30-year period. Some construction-related effects, on the other hand, such as visual and noise nuisances, will be short-term in nature and should be noted.

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In establishing the baseline conditions, the planner is primarily interested in the existing conditions for those impact indicators that describe the impact issue. Establishing the baseline will be more straight forward for some impact indicators than others. For example, if the impact indicator is the increase in construction jobs associated with a new sewage treatment plant, then a profile of baseline construction employment would include the number and distribution of construction jobs in the impact area. Data is normally available for many of the socioeconomic impact categories, such as land use, employment, housing, population, and public services. These sources are listed in each of these categories in Part 2. The problem in establishing baseline conditions in the impact categories, however, may stem from the availablility of data for the year in which the baseline is being established. It may be necessary to gather primary data in these cases if the effort is expected to be minimal.

Step 4: Perform Impact Measurement

In this step, impacts are measured in as many of the dimensions indicated in Section 4.2 as possible, namely:

- Magnitude
- Direction
- Timing
- Duration
- Incidence

The most intensive aspect of this step will be the measurement of the magnitude of the impact. Impact measurement techniques for a number of impact indicators in each socioeconomic impact category considered in this guidebook are presented in Part 2.

While the appropriate measurement technique will have been selected prior to this step, the actual measurement process may reveal the need to select an alternative measurement approach. If, for example, a broad-brush measurement technique reveals an impact in an important impact area of greater-than-expected magnitude, the planner may wish to use a more sophisticated technique.

Step 5: Present and Display Impacts

The portrayal of impact information is a key aspect of impact assessment. Information has to be presented in a clear and understandable format. When impact assessment is concerned with the comparison of alternatives, impact information should be presented in a framework that will enable the selection of alternatives to take place. There are a variety of mapping and graphic techniques that are useful in presenting individual impact information for one or more alteratives. Some are briefly presented in Examples 4-4 through 4-8.

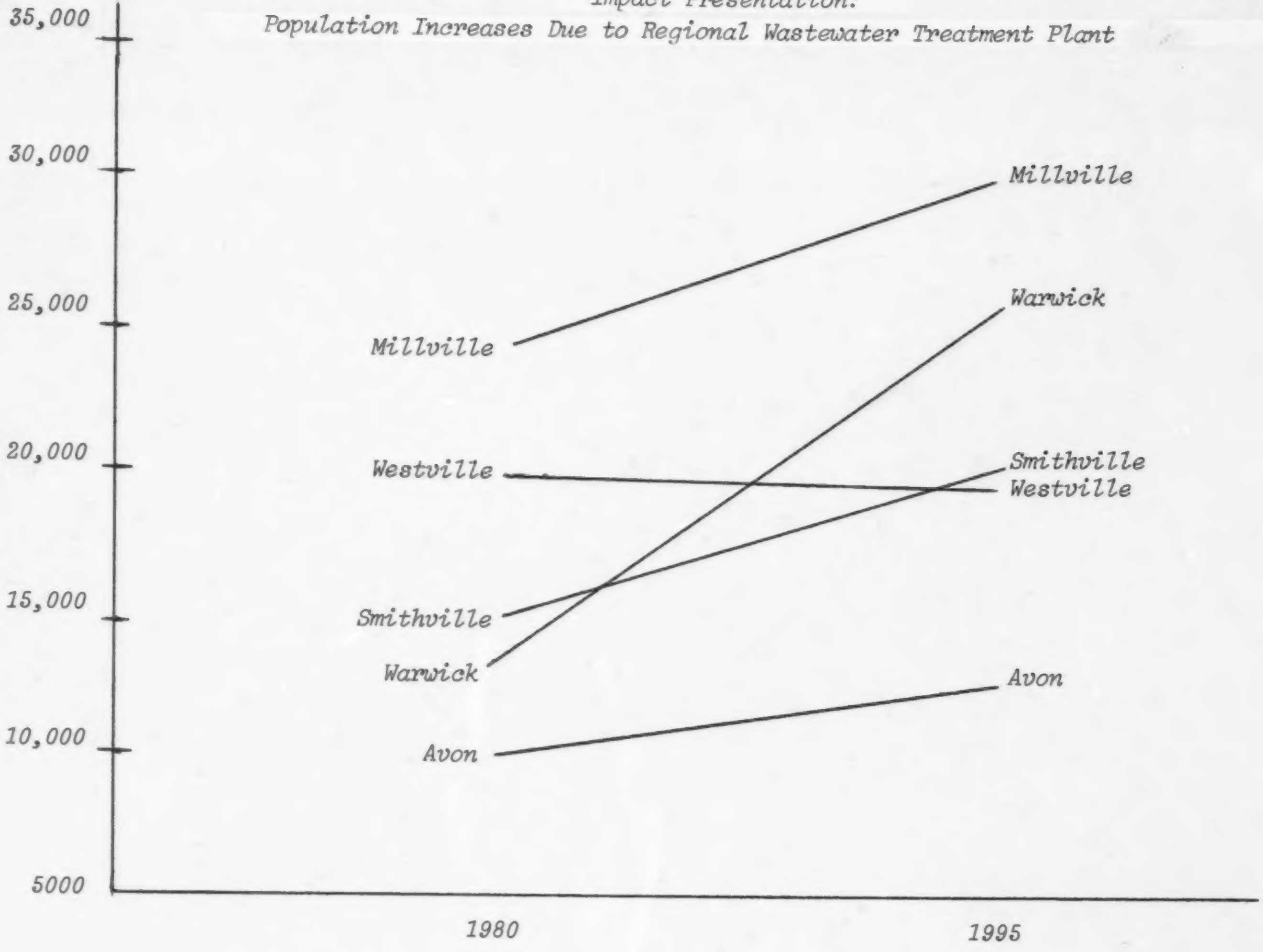
The presentation of impact information in water quality decision-making is complicated when there are several impact measures to be considered and more than one decision-maker. For example, in the case of the Smithville

1-4

lower by 1/2"

Example 4-4

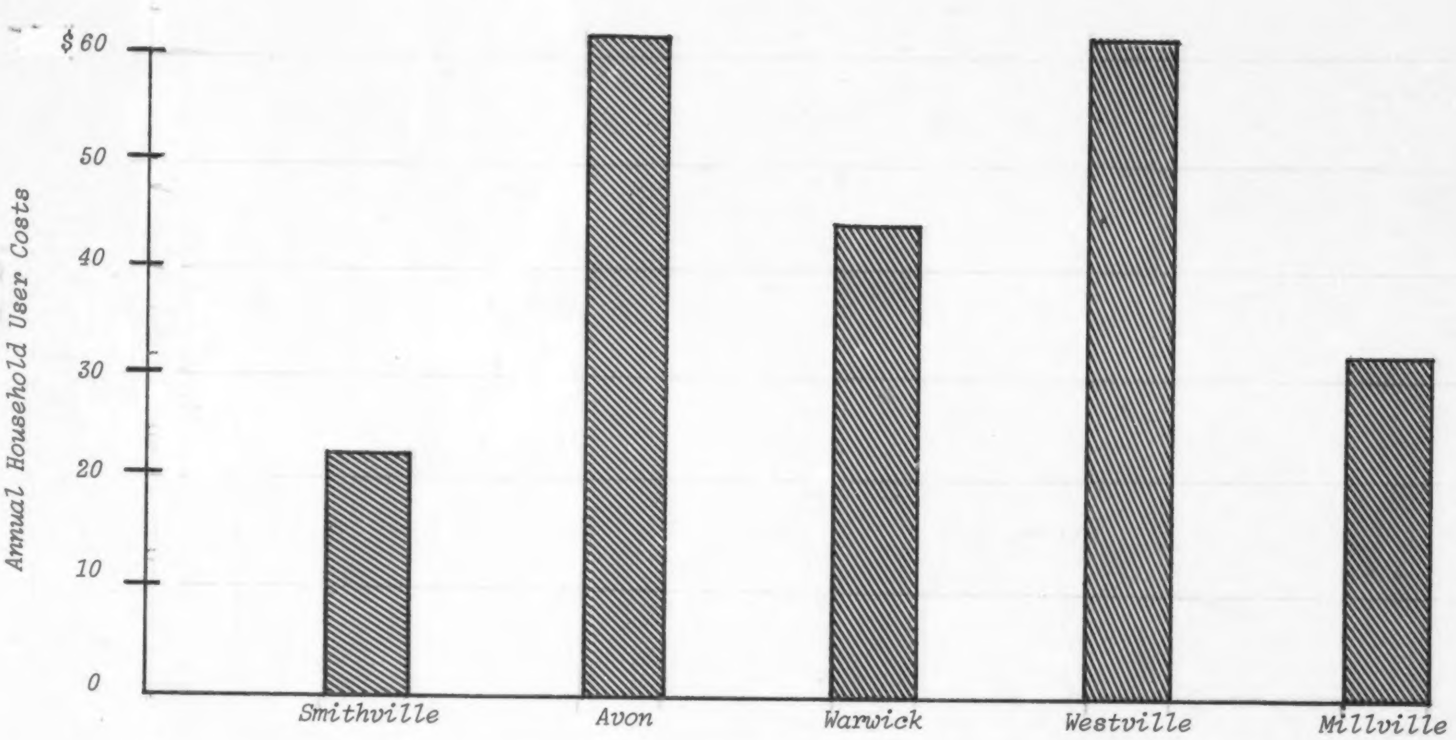
Impact Presentation:
Population Increases Due to Regional Wastewater Treatment Plant



54

Example 4-5 4-5

Impact Presentation: Annual Household User Cost Impacts of Regional Wastewater Treatment Plant



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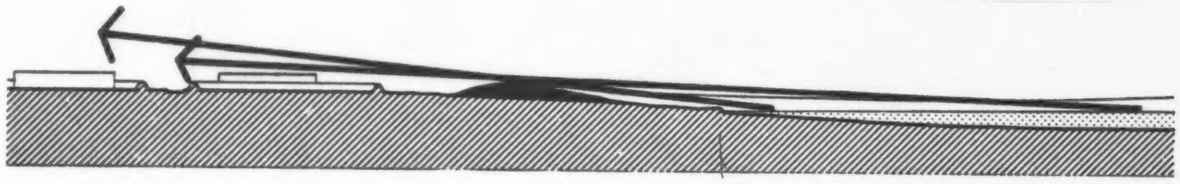
4-6

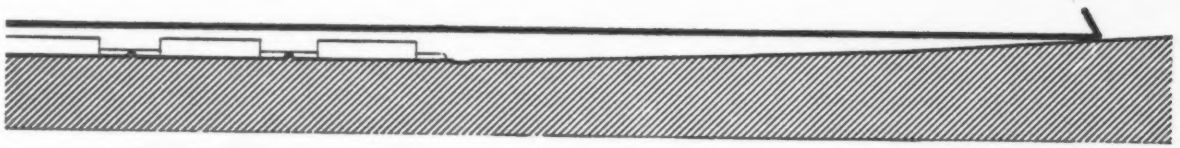
↓ lower 2 1/2" and center

Example 4-6

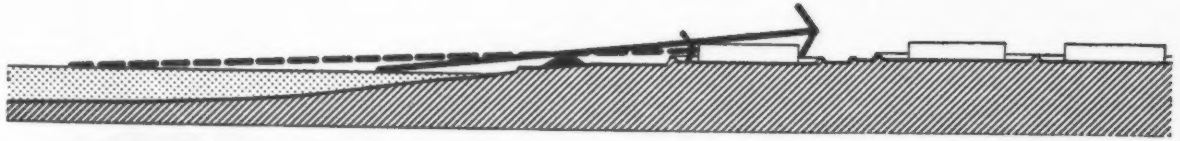
Impact Presentation: Visual Effects of Wastewater Treatment Plant



Looking west towards Skunk Hill



Looking north towards State Park



Looking east

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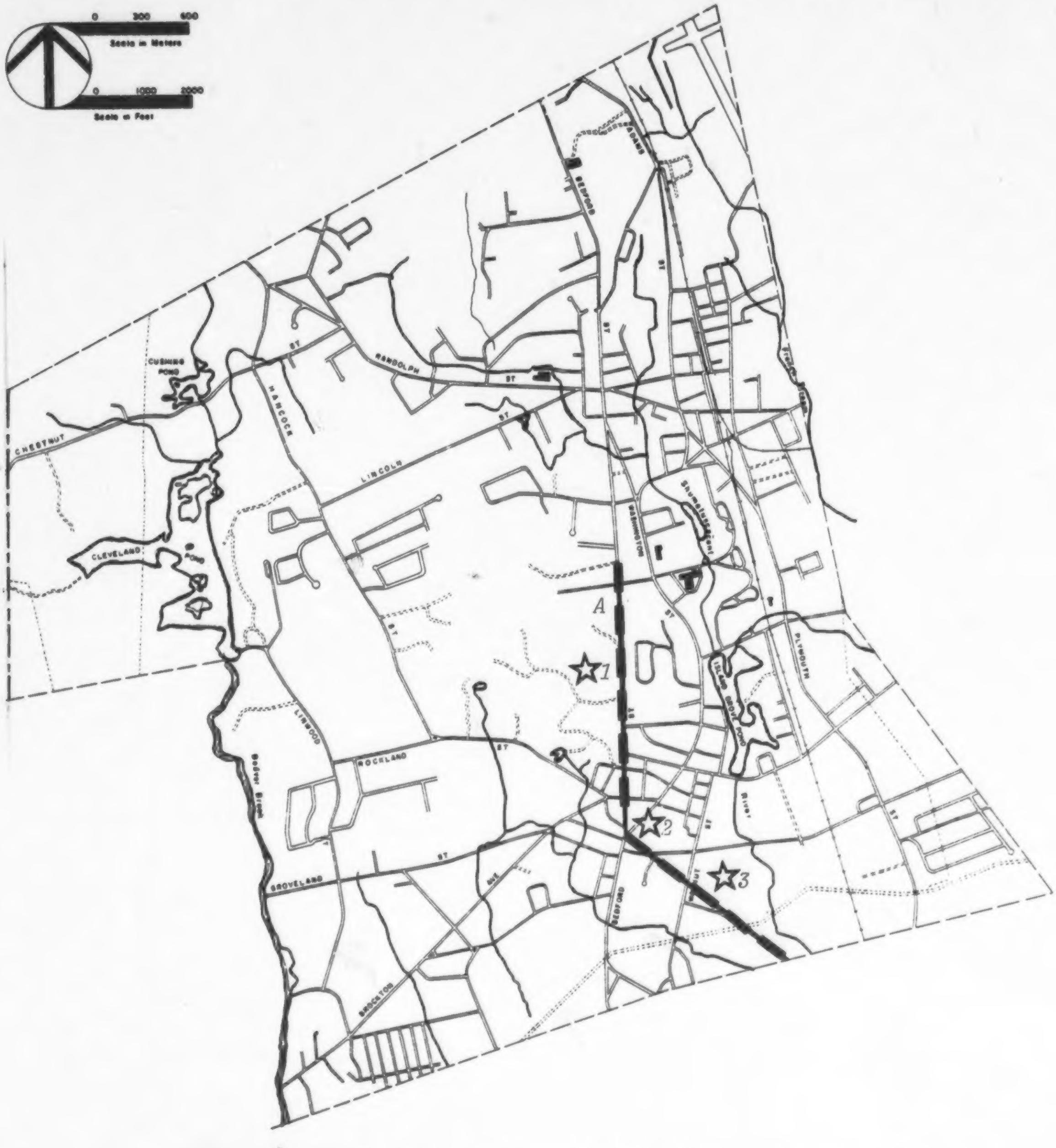
4-7

locate this as shown

Example 4-7

Impact Presentation: Historic Locations Affected by Interceptor Route A



☆1 -- Valley View Farmstead National Register Site

☆2 -- Town Square Historical District

☆3 -- Chepachet Indian Burial Area

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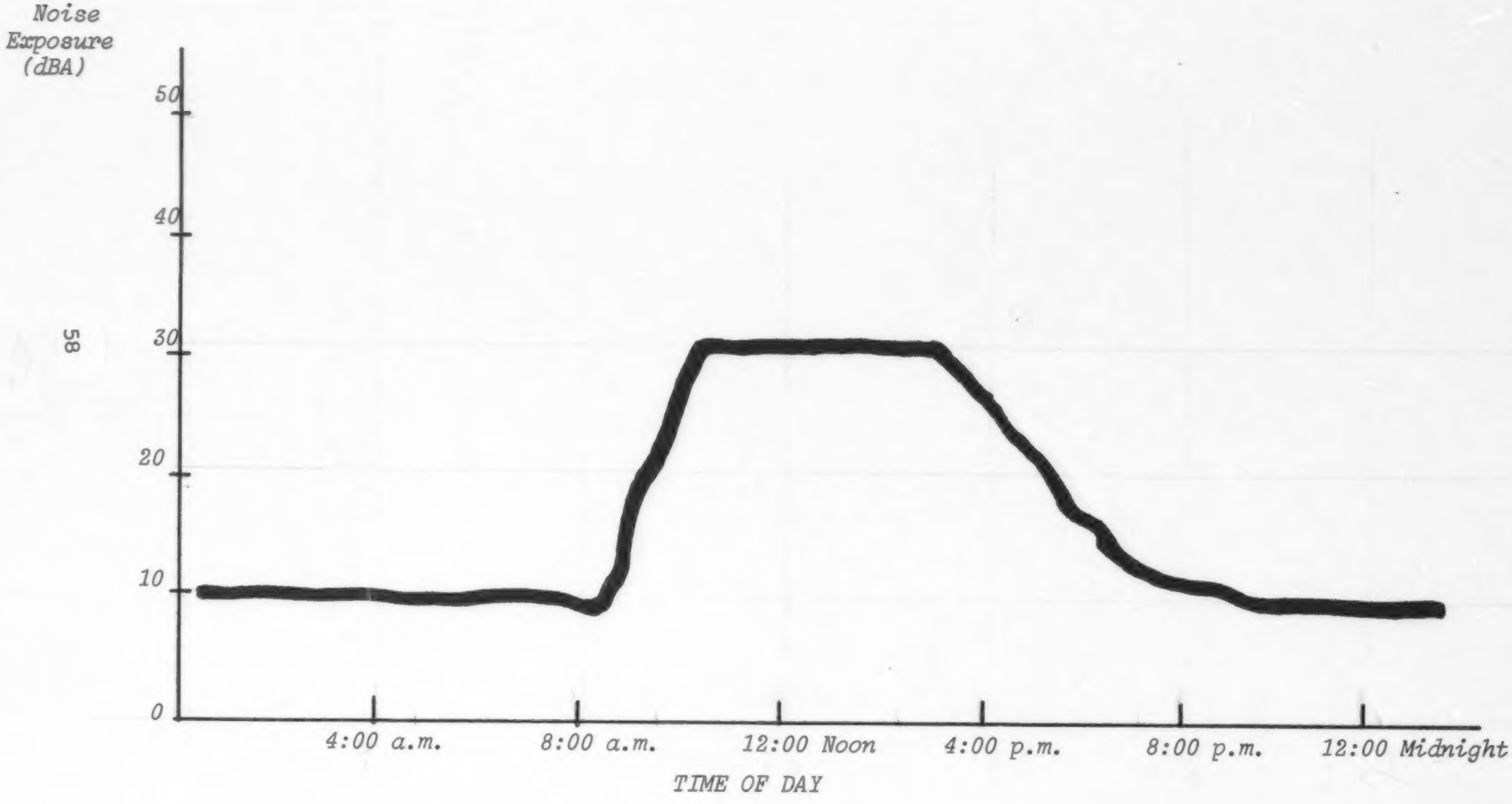
4-8

[illegible] as shown

Example 4-8

in Rolling Hills Subdivision

Impact Presentation: Expected Wastewater Treatment Plant Noise Exposure in Rolling Hills Subdivision



58

sewage treatemnt facility used throughout this chapter, the prsentation of impact information is more complicated if it is a regional facility that will serve four other communities. In areawide water quality planning, impact asessment will typically involve comparing alternatives and their related impacts across several watersheds or communities.

The problem in presenting impact measurement information results from the number of dimensions associated with impact measurement, i.e., magnitude, direction, timing, duration and incidence. When all of these dimensions have to be considered for several alternatives involving several impact indicators, then the presentation of impact data is particulry difficult in a two-dimensional matrix. It is impractical to attempt to create a single matrix will all of the desired information.

Four different types of matrices, shown in Examples 4-9 through 4-12, are suggested as appropriate for displaying these dimensions given more than one alternative. Example 4-9 is an "impact type" matrix in which, for a specific impact indicator, impact magnitude is displayed for various alterntives in various affected areas. This type of matrix is most relevant when an impact issue, say household user costs, is perceived as particulrly important in the evaluation of alternatives. The "alternative-type" matrix shown in Example 4-10 highlights the differences among areas in several impact categories for one particular alternative. Finally, Examples 4-11 and 4-12 illustrate an "area-type" matrix which is useful for decision-makers in one particular area in comparing alternatives across several impact categories.

The choice of matrix type will depend on the type of evaluation process that will take place in the assessment process, importance of individual impact issues, the number of geographic areas of interest, and the number of alternatives. The alternative-type and area-type are the most commonly used types of impact display matrices. The alternative-type is particularly useful when there are substantial differences among alternatives in several areas. The area-type matrix is useful when the number of affected areas is small but there are a number of alternatives to consider. It may be appropriate to display information in one matrix, and use one of the other matrices to supplement the basic matrix.

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Example 4-9 9

IMPACT-TYPE MATRIX

Impact Category: *Annual Household user costs ($/household)*

Alternatives / *Areas*	*A*	*B*	*C*	*D*	*E*
Smithville	*$26*	*$50*	*$55*	*$89*	*$31*
Westville	*67*	*61*	*48*	*29*	*64*
Millville	*31*	*58*	*51*	*79*	*28*
Warwick	*41*	*70*	*62*	*48*	*27*
Avon	*67*	*58*	*57*	*36*	*78*

A,B,C,D,E are various sewage interceptor routes for a proposed regional sewerage facility

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(4-76)

Example 4-10 10

ALTERNATIVE-TYPE MATRIX

Alternative: Interceptor Route A

Area Impact Indicators	Smithville	Westville	Millville	Warwick	Avon
Visual conflicts	Slight	Extensive	Slight	Moderate	Slight
Annual household user costs	$26	$67	$31	$41	$67
Annual household non-user costs	$15	$16	$20	$11	$28
Population increases 1980-1995 (persons)	1200	400	2000	800	350
Land pre-empted (acres)	75	220	100	50	300
New manufacturing jobs	0	600	700	100	1500
Historic locations adversely affected	0	1	4	0	12

Example 4-11 -11
AREA-TYPE MATRIX

Community: *Smithville*

Alternatives / *Impact Indicator*	*A*	*B*	*C*	*D*	*E*
Visual conflicts	*Slight*	*Moderate*	*Moderate*	*Slight*	*Extensive*
Annual household user costs	*$26*	*$50*	*$55*	*$89*	*$31*
Annual household non-user costs	*$15*	*$31*	*$33*	*$48*	*$18*
Population increase 1980-1995 (persons)	*1200*	*1000*	*1200*	*1200*	*1200*
Land pre-empted(acres)	*75*	*60*	*80*	*350*	*100*
New manufacturing jobs	*0*	*250*	*250*	*600*	*0*
Historic locations affected	*0*	*3*	*3*	*8*	*2*

A,B,C,D,E are various sewage interceptor routes for a proposed regional sewerage facility.

Example 4-12 2
AREA-TYPE MATRIX

Area: South River Basin (Smithville, Westville, Millville, Warwick, Avon)

Alternatives Impact Indicators	A	B	C	D	E
Visual conflicts	Slight	Slight	Moderate	Moderate	Extensive
Annual household user costs	$39	$61	$57	$65	$30
Annual household non-user costs	$17	$22	$20	$24	$15
Population increases 1960-1995 (persons)	4750	6500	3200	9000	8500
Land pre-empted (acres)	745	600	650	900	550
New manufacturing jobs	2900	3800	3000	3200	4000
Historic locations affected	17	5	13	2	31

A,B,C,D,E are various sewage interceptor routes for a proposed regional sewerage facility.

CHAPTER 5
Impact Evaluation

5.1 INTRODUCTION

The first two impact assessment tasks are concerned with the identification and measurement of socioeconomic effects associated with alternative water quality control strategies. The third task is concerned with developing an approach for evaluating and ranking water quality control strategies. The essence of the evaluation process is the comparison of the impacts associated with each alternative, in order to illustrate the significant similarities and differences for decision-making.

Only if an impact-by-impact comparison indicates that one alterative consistiently offers higher benefits is the choice of a "best" alternative obvious. In reality, a point-by-point comparison generally yields ambiguous results: one alternative may proffer both greater benefits and higher costs than another alternative; certain impacts may occur wth one alternative, but not another. In such cases, the ranking among alternatives is not clear. The selection of the"best" alternative depends upon the relative importance or weight given by the evaluator to one impact versus another. This is made more problematical when both quantifiable and nonquantifiable impacts are involved.

Another problem which may arise in the ranking of alternative water quality management strategies is that of multiple decision makers or interest groups. For any particular impact arising from a specific alternative, a number of groups may be affected. These groups may include residents, businessmen, farmers, developers, fishermen, boaters, elderly, poor, etc. Various geographic groups may also be affected: those in the immediate vicinity of a facility, those in the surrounding neighborhood, the community as a whole, and in the region. Each group may perceive a particular impact in a different way. Both the magnitude and direction of a perceived impact may vary, from extremely adverse to extremely beneficial. In addition to these varying types of incidence of the expected impacts, the relative importance associated with each impact issue may vary across the interest groups.

Section 5.2 suggests criteria that may be used by evaluators in determining the significance of individual consequences of an alternative. The evaluation process may be simplified if unworthy alternatives are eliminated prior to detailed evaluation. Section 5.3 presents several screening techniques which may be used to narrow the evaluation process to the best alternatives. The next several sections discuss a variety of comprehensive evaluation techniques. Unlike the previous impact assessment tasks, where specific steps are prescribed, this chapter suggests several atlernative techniques of varying complexity for decision-makers to use in the evaluation process.

5.2 DETERMINING THE SIGNIFICANCE OF AN IMPACT

At the heart of the alternative evaluation process is the evaluation of each impact measure. Whatever technique is used to evaluate or compare alternatives, each technique requires an initial evaluation of the individual impacts or attributes of an alternative.

The impact measures, or attributes, spell out the consequences of an alternative. The significance or importance of these consequences depends on the value that each evaluator places on the consequences. This valuation process may be done implicitly or explicitly. There are several explicit means for determining significance, including the following:

- Comparisons with objectives;
- Comparisons with existing conditions;
- Precedent-setting change; and
- Impact incidence.

Each of these is discussed below.

Comparisons with Objectives

An objective may be defined as a desired course of action and is normally considered to be an attainable goal. The objective serves as a standard against which the impact result may be compared. The variation of the impact result from the stated objective provides a basis for valuing the impact result. For example, if one of the stated objectives of an area is to keep the unemployment rate below 5%, and alternative sewer plans for Smithville will have varying impacts on employment in the community, then it is possible to determine the significance of the employment impacts with respect to the unemployment objective.

The use of objectives as a yardstick for evaluating impacts depends on the ability of the evaluator to be aware of articulated objecives. The presence of a comprehensive package of socioeconomic objectives in a community is unlikely. There are a number of ways in which objectives may be determined. Objectives may be determined directly by large-scale survey techniques but this is an expensive proposition for a water quality planning process. Alternatively, the Advisory Committee or other public participation mechanims can be used to directly determine objectives with respect to the impact issues being considered. It is also possible to use indirect sources to infer community objectives for many of the impact issues. The reliability of these inferences should be carefully considered. For example, it is possible to indirectly determine objectives from newspaper articles, public meeting records, elections and other secondary sources, but they require careful interpretation before describing an objective to these sources. More reliable indirect sources include standards that have been formally incorporated into by-laws, ordinances, and judicial opinions.

Briefly described below are two ways in which socioeconomic objectives may be articulated.

Performance Standards and Carrying Capacity--

The use of performance standards as a means for evaluating impacts has become increasingly popular at the local and national level. Water quality and air quality standards are prime examples of performance standards used in environmental assessment. The use of performance-based local land use controls began in the 1950's, but has only achieved widespread use in the past ten years. The use of performance standards for socioeconomic conditions has proceeded on a more tentative basis as there is less certainty as to what constitutes acceptable standards. The Public Services impact category, for example, has a number of performance standards, such as teacher/pupil ratios or the number of acres of recreation land/1000 people. There is less agreement on many of these socioeconomic impact performance standards, however, and it is perhaps more appropriate to label these standards as suggested guidelines or "rules-of-thumb." In any case, local and national socioeconomic standards should be considered as means for evaluating the significance of water qulity-realted socioeconomic impacts.

Closely related to the notion of performance standards is carrying capacity. The latter often is the basis for establishing performance standards. Standards for environmental carrying capacity are generally based on some estimate of the limits of a natural resource. For socioeconomic impact issues, on the other hand, quality of service or quality of life considerations are often used to express carrying capacity. The number of visitor-days for a particular recreation facility or average daily traffic for a highway are examples of carrying capacity concepts used in establishing performance standards. While public services have been one of the most fertile socioeconomic areas for carrying capacity concept, the notion is spreading to other socioeconomic impact issues as well. For example, the fiscal capacity of a community may be evaluated according to a number of performance standards, including the following: amount of per capita debt, percentage of uncollected taxes, amount of debt/assessed valuation. The evaluation of such fiscal performance standards will in part determine a community's credit rating.

Thresholds--

Thresholds are akin to perforance standards in that they represent yardsticks against which to evaluate impact results. They are distinguished from performance standards in the degree of specificity in which they are normally defined. While performance standards are generally expressed in specific terms, and define upper or lower limits of an action, thresholds serve more like red flags or warning signals and may be expressed in ranges. For example, population increases normally trigger higher order public service impacts. The carrying capacity for a number of public services will be affected by different population increases. It may be difficult to translate specific population levels into specific capacity overloads for a public service. Consequently, the threshold for a public service capacity, such as water supply, may be a population increase of 4,000-5,000 people.

The water supply system may in fact be able to adequately supply water beyond this population increase. The 4,000-5,000 figure, however, provides a warning signal about capacity.

EPA has recently applied the threshold concept to individual cost burdens arising from public sewer projects. The threshold is based on annual user costs at a percentage of median family income. If, for example, the annual user costs associated with a proposed sewer alterative exceed 1% of median family income of $10,000, the alternative is considered too much of a cost burden and EPA requires modification or rejection of the alternative.

Comparisons with Existing or Without Project Conditions

Using this criteria, the evaluator may value the consequence of an alternative based on the amount of relative change that the consequence represents. A convenient yardstick against which to measure relative change is the exising condition of the impact issue or the projected measurement for the impact issue without the proposed alternative. As discussed in Chapter 4, these respective yardsticks are the two different ways in which impact magnitude may be defined. What is suggested under this approach is that the impact magnitude be expressed as relative change. Thus, a value may be placed on an impact consequence not in terms of its absolute meaning, but rather in terms of its relative change. This simply requires the use of the ratio of impact magnitude to "existing" conditions or to "without project" conditions.

In the absence of well-defined performance standards and other objectives, this technique probably is one of the most widely-used means for evaluating individual impacts. Relative change is particularly well understood by the public and is thus quite useful, when values are solicited from the public. It is easy for the public to identify with impact consequences phrased in terms of the following: "This alternative will increase manufacturing jobs in Smithville by 60%."

Precedent-Setting Change

This criterion for evaluating an impact result is more value-laden than the above approaches. The actual impact consequence of a water quality alternative may be relatively small but the nature of the impact may be such that it is a significant impact. Two examples illustrate this criteria. In Example 4-1, the acres pre-empted for the interceptor routes in Smithville are not terribly large in any alternative. The acreage exempted, however, may have significant value in Smithville far beond the magnitude proposed for taking. If, for example, the acreage in Alternative B includes the last working farm in Smithville, then its signifiance may be greater than the impact in Alternative D where far more acreage is concerned. This is a good example where, perhaps, another impact measure might have been appropriate, such as the "number of farms displaced." Since sewers in Smithville may allow higher density development to occur, this is a very plausible impact. If there are no apartments in Smithville, this type of impact may be considered precedent-setting. Even if only 75 units of new apartments are projected for any alternative, the magnitude may not be the critical issue. The fact that apartments are a precedent-setting land use in Smithville may be the issue affecting the significance of the impact issue.

Incidence

This criterion recognizes the distribution of the impact consequence rather than the magnitude of the impact as the factor affecting significance. Incidence may be used as a means for defining significance in either a single-decision maker or multiple-decision maker situation. In Example 4-9, assume a single decision-maker is the model. If one of the concerns of th decision-maker is the equity of annual household user costs, then Alternative C would be valued fairly high because of the distribution of annual household user costs in each of the five affected communities. If there are multiple decision-makers involved, however, from the point of view of Smithville and Millville, Alternative A is clearly more valued than Alternative C.

This example clearly indicates the importance of point of view in the determination of significance levels for individual impacts. It also shows that incidence is an important factor to use in determining impact significance even if there is only one decision-maker.

5.3 SCREENING TECHNIQUES

Introduction

The screening approaches presented in this section will not generally lead to a ranking of alternatives. Screening provides a process of sequentially comparing alternatives on the basis of impact values so that alternatives may be eliminated or retained for further consideration. Alternatives are generally classified into one of two categories: "acceptable" or "unacceptable." Without further information, no choice can be made among the acceptable alternatives. Therefore, a ranking approach must then be applied to this smaller set of alternatives, involving less effort than if applied to the entire set of alternatives. As a first step then, screening may eliminate from further consideration alternatives which are unlikely to be contenders for the best choice.

Search for Noninferior or Nondominated Alternatives

This technique involves the comparison of the impacts of one alternative with the impacts of another alternative, considering all impacts simultaneously. The process considers "dominated" and "nondominated" alternatives. If one alternative has impact values that are at least as good as those of a second alternative, for all impact categories, and if the first alternative has one or more impact levels which are strictly better than those of the second alternative, then the second alternative is dominated by the first, and should be eliminated from further consideration. However, a complete ranking of the alternatives cannot be obtained, since no choice may be made among the dominated alternatives or nondominated alternatives without further preference information.

The search for nondominated alternatives involves pairwise comparisons of the alternatives, say, alternative p and alternative q. If alternative p dominates alternative q, then alternative q is eliminated from further consideration. Likewise, if alternative q dominates alternative p, then alternative p is excluded. If neither alternative dominates the other, then both are retained and additional comparisons are made between those alternatives and other alternatives. Once all pairs of alternatives have been compared in this fashion, the remaining alternatives are nondominated. Note that once an alternative has been eliminated as being dominated, it need not be considered in any more comparisons.

Eliminating the dominated alternatives serves as a useful first step, before applying any of the other screening or ranking techniques to determine a best alternative. If there is a unique nondominated alternative, then the choice is obvious. In most cases, however, further evaluation must be made of the tradeoffs among the various impact categories.

Conjunctive Screening

Conjunctive screening implies that all constraints or standards must be satisfied for an alternative to be considered acceptable. All factors are used simultaneously and an alternative must be acceptable with regard to each coequal factor. The procedure cannot differentiate among acceptable alternatives, since no preference information is employed. The methodology is simple and ensures that all relevant constraints are satisfied.

The approach may be used to eliminate alternatives which do not reach minimum acceptable levels (lower bounds) or which exceed maximum acceptable levels (upper bounds) of various impact measures. For an alternative to be acceptable, all such constraints must be satisfied. However, the procedure makes no distinction between alternatives which just barely meet the criteria and those which satisfy the conditions with room to spare. The decision-maker might vary the levels of the acceptable levels to check the sensitivity of the acceptable set of alternatives to the particular values of the bounds. The bounds might be varied to determine how much change would be required to exclude one more alternative or, alternatively, to include one more option. Such screening is inexpensive and doesn't require refined impact data. The comparisons result in a set of "go-no go" decisions, all of which must be answered in the affirmative for an alternative to be considered acceptable.

An example illustrating the application of the conjunctive screening process is presented in Example 5-1. Two impact categories are presented: x_1, the number of present vacant acres opened up for development, and x_2, the number of existing industries capable of connecting to the sewerage system. The corresponding lower bounds are x_1 and x_2. In this particular case, no upper bounds are specified. The cross hatching indicates the acceptable region. Alternatives A, B, and C are all acceptable. Alternatives D, E and F are all unacceptable, since they violate one or both of the constraints.

Other than saying alternatives A, B, and C are all acceptable, no further differentiation may be made among the alternatives without preference information. The fact that alternative B may be farther from the bounds than the other alternatives does not imply that alternative B is any better or any worse than either of the remaining acceptable alternatives. If both of the bounds were reduced slightly, alternative F might then become acceptable, while increasing one of the bounds might eliminate alternative A or alternative C.

In the example shown in Example 5-2, upper bound constraints are incorporated into the example via two additional impact categories. One impact category, x_3, is the number of acres of community parks disturbed by the construction of the interceptors; while x_4 is the community's amount of municipal bonded debt. In this example, x_3 and x_4 represent maximum levels of acceptability. In order for the alternatives to pass the screening test, they cannot violate any of the constraints. In this particular case, again only alternatives A, B, and C are acceptable. Alternatives D, E, and F each violate one or more of the constraints.

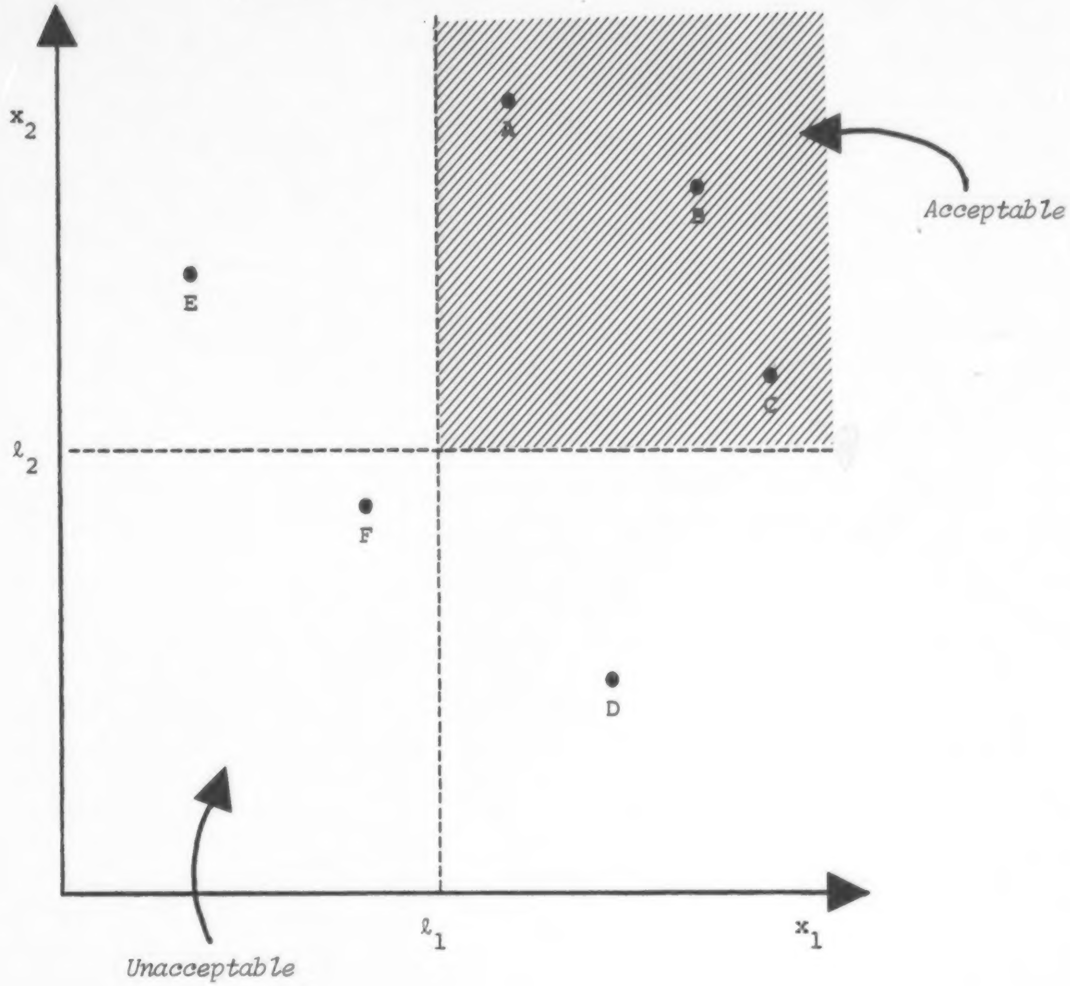
While these examples have used constraints associated with the magnitude of impact measures as a means for screening out alternatives, impact incidence could also be incorporated as a constraint and screened using the conjunctive screening technique.

5-1

lower only 1/2"

Example 5-1

Conjunctive Screening



Alternatives

A
B
C
D
E
F

Various public sewerage interceptor location alternatives

Socioeconomic Impact Indicators

x_1 = *# of vacant acres opened up for development*

x_2 = *# of existing industries capable of connecting to the sewerage system*

Constraints (all must be met)

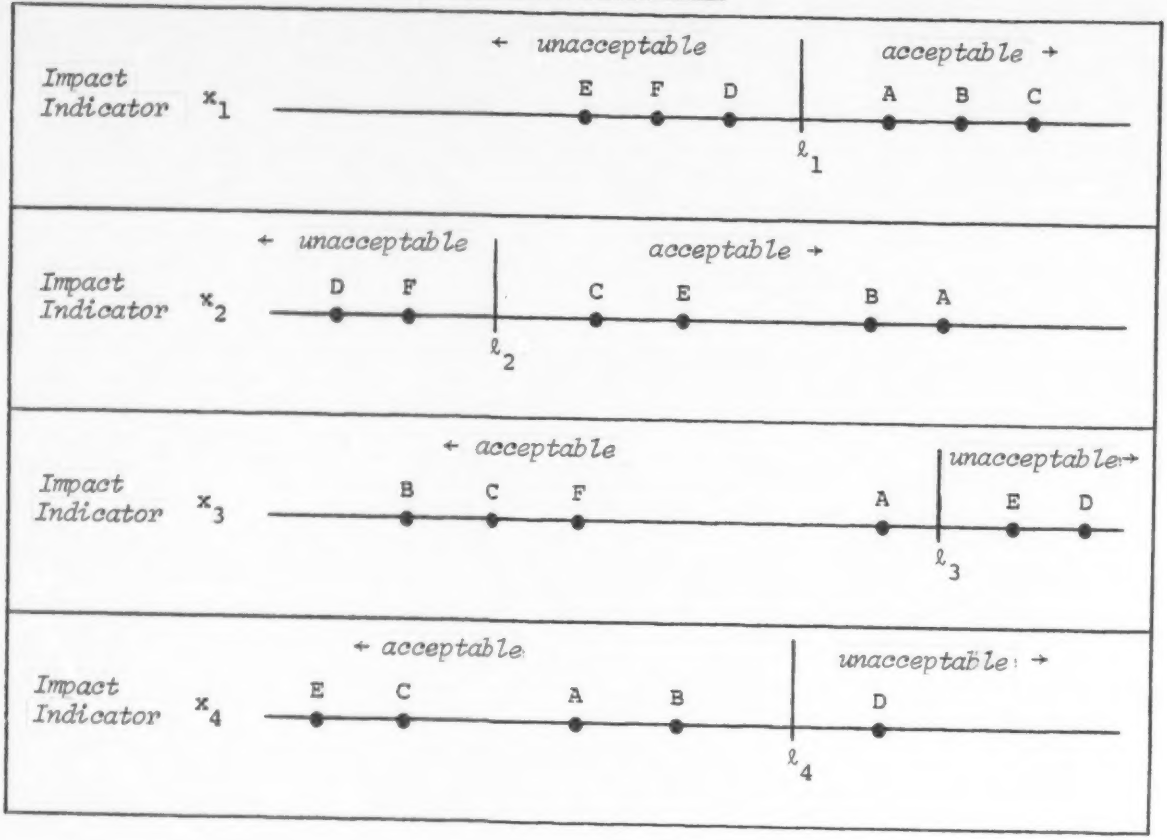
ℓ_1, ℓ_2 = *minimum acceptable levels for* x_1, x_2 *respectively*

5-2

lower by 1/4"

Example 5-2

Conjunctive Screening



Impact Indicators

x_1 = *# of vacant acres opened up for development*

x_2 = *# of existing industries capable of connecting to the sewerage system*

x_3 = *# of acres of community parks disturbed by construction*

x_4 = *municipal bonded debt*

Alternatives

A, B, C, D, E, F *are various sewerage interceptor location alternatives.*

Constraints (all must be met)

ℓ_1, ℓ_2 = *minimum acceptable goals*

ℓ_3, ℓ_4 = *maximum acceptable levels*

Acceptable Alternatives

A, B, C

Unacceptable Alternatives

D, E, F

72

Disjunctive Screening

This approach represents a variation of the conjunctive screening technique in which an alternative need only pass some specified fraction of the conditions to be acceptable, rather than being required to satisfy all of those criteria. No one condition may be considered exclusionary by itself. For example, assume that p out of the N constraints must be satisfied. Conjunctive screening is a special case of disjunctive screening, with p=N, implying that all constraints must be satisfied. If p=N-1, then any one of the constraints may be violated, for p=N-2, any two of the constraints may be violated, etc. The smaller the ratio of p to N, p/N, the less restrictive the screening process. In the extreme, p=1 excludes an alternative only if all of the constraints are violated, and p=0 excludes none of the alternatives, since all of the constraints may be violated.

Using the same example as presented in Example 5-2 in the discussion of conjunctive screening, now assume that only one of the two constraints must be satisfied, for an alternative to be acceptable, as shown in Example 5-3. The cross-hatching indicates the acceptable region, which is now much larger than in the case of conjunctive screening, where both of the constraints must be satisfied. As before, alternative A, B, and C are still acceptable, since both conditions are met. However, now alternatives D and E are acceptable, as well, since only one of the two conditions is violated. alternative F is the only option which is unacceptable, since both conditions are violated. Other than saying that alternatives A, B, C, D, and E are all acceptable, no further differentiation may be made without preference information. While alternative F violates both criteria slightly and is considered unacceptable, alternative E violates the constraint on x_1 by a large margin, but is considered acceptable, since the constraint on x_2 is satisfied.

Lexicographic Screening

Unlike the disjunctive screening process, lexicographic screening ensures that the most important criterion is always considered. In disjunctive screening, the most important criterion might be violated, but an alternative could still be acceptable, if the other, less important, conditions are satisfied. In the lexicographic screening approach, however, the lower-ranked factors need not necessarily be considered. If all factors are considered, then the lexicographic approach is identical to the conjunctive screening approach.

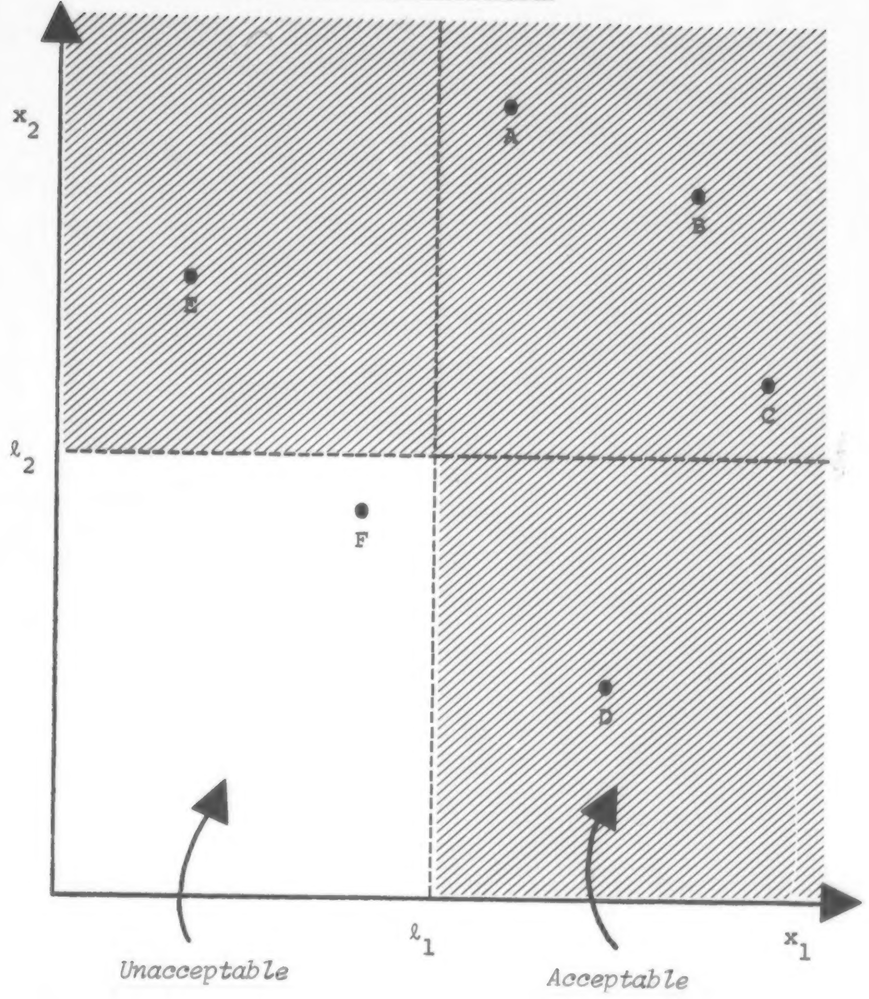
The process starts by identifying all those alternatives which satisfy the most important conditions. If only one alternative meets that condition, then that alternative is chosen as the optimal choice. If more than one alternative meets that condition, then those alternatives are screened according to the second most important condition. Again, if a single alternative meets that condition, then that alternative is optimal; otherwise, the set of alterntives passing the second screening test are screened

30 5-3
30

Increase by ½"

Example 5-3

Disjunctive Screening



Alternatives

A, B, C, D, E, F: *Various public sewerage interceptor location alternatives.*

Socioeconomic Impact Indicators

x_1 = *# of vacant acres opened up for development*

x_2 = *# of existing industries capable of connecting to the sewerage system*

Constraints *(only 1 of which has to be met)*

ℓ_1, ℓ_2 = *minimum acceptable goals*

74

according to the third criterion. The process continues until a single alternative remains or all criteria have been considered. If all of the conditions or constraints have to be met, then the set of alternatives that result from lexicographic screening is identical to the set of acceptable alternatives resulting from the conjunctive screening process. Referring to the example shown in Example 5-4 with minimum levels ℓ_1 and ℓ_2, associated with impacts x_1 and x_2, respectively, assume that x_1 is the most important impact. Therefore alternatives E and F would be screened out in the first step. Once both impacts are considered, the results are identical, regardless of the order, and only alternatives A, B, and C remain, as in the case of conjunctive screening.

Summary

The search for nondominated alternatives is a basic screening approach that should be applied to a set of alternatives before any of the other screening approaches or comprehensive evaluation techniques are applied. It is a very useful efficient means for eliminating inferior alternatives from further consideration.

The use of the other screening alternatives is optional. Where there are a number of alternatives still in the running, even after nondominated alternatives have been identified, the screening techniques may be used to narrow down the set of alternatives to a manageable number. Caution is advised however, in using these techniques as the examples have shown, they can be very powerful techniques. Determining "acceptable" standards and constraints in terms of socioeconomic impacts can be very arbitrary and problematical. As discussed in Section 5.2, performance standards for most socioeconomic impact categories have not been established with as much certainty as they have in other environmental impact categories. Where readily accepted standards don't exist and where local objectives setting activities in the water quality planning process is being used to define those cut-off points, considerable discretion is urged. To use highly disputed constraints in such a powerful screening tool as conjunctive screening may result in attractive alternatives being prematurely eliminated.

5.4 COMPREHENSIVE EVALUATION TECHNIQUE: BALANCE SHEET METHOD

Description

The balance sheet approach is one of the most widely used evaluation techniques in evaluating alternatives. In this approach the information from the impact measurement step is presented without alteration to the decision-maker(s). Impact information is not reduced to commensurable units or compared to standards or objectives. Each decision-maker simply implicitly superimposes a set of values and weights on the information to reach an overall judgement regarding the "best" alternative.

A variation on the simple balance sheet method is the ranked balance sheet approach. The same implicit approach is applied by the decision-

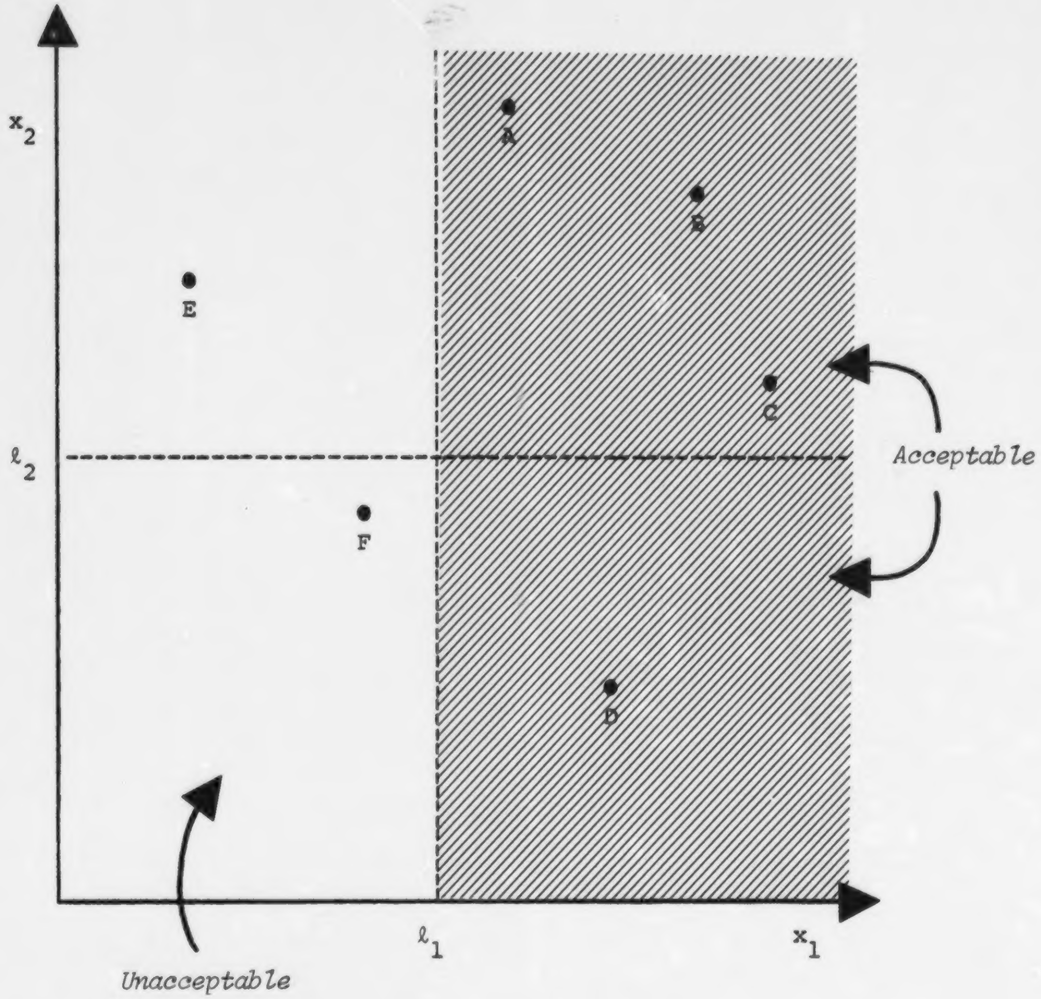
5-4

4

Lower by 1/2"

Example 5-4

Lexicographic Screening



Alternatives

A
B
C
D
E
F

} Various public sewerage interceptor location alternatives

Socioeconomic Impact Indicators

x_1 = # of vacant acres opened up for development

x_2 = # of existing industries capable of connecting to the sewerage system

Constraints (ℓ_1 must be met)

ℓ_1, ℓ_2 = minimum acceptable levels for x_1, x_2 respectively

76

maker(s). Instead of a best alternative, alternatives are ranked. The ranking is typically done on an ordinal basis, i.e., A > B > C > D > E >, or whatever ranking is derived. It is possible to say, for example, that Alternative A is prefered to B or B is preferred to C, but one can't say how much more preferred. Example 5-5 illustrates the ranked balance sheet approach.

Discussion

Balance sheet methods avoid many of the technical problems associated with scoring impact results or weighting impact attributes. The attractiveness of this "non-scored" plan stems, to a large degree, from the practical and political difficulties associated with scoring and weighting. While the balance sheet approach can be considered an optimization technique, it fails to explicitly consider how the best alternative or ranking is determined. This makes it impossible to consider tradeoffs among alternatives or to suggest impacts that should be modified by mitigation measures. The balance sheet approach is often a good technique to initially use in an evaluation process. It commits decision-makers to a choice. These choices, in turn, then can be considered by the decision-makers in explicitly defining weights and values. Without giving some explicit consideration to these issues, the Balance Sheet method basically resembles a black box approach for evaluation.

5.5 COMPREHENSIVE EVALUATION TECHNIQUE: GOALS ACHIEVEMENT ACCOUNT

Description

The fundamental requirements of the Goals Achievement approach is the prior articulation of goals or objectives before evaluation. Objectives must be generated for each impact issue. This is somewhat similar to the Constraints approach where minimum and maximum levels are set for each impact issue except for one. Unlike the Constraints approach, the levels set in the Goals Achievement approach are goals--not "accept-reject" threshold values. The Goals Achievement approach is an optimization method like the Balance Sheet method except that goals to which impact outcomes can be compared are explicitly stated.

The variations in this approach revolve around the extent of rating or scoring of the impact consequences with respect to the goals; and the relative weights attached to the impact issues. In the Scored Goals Achievement Account, shown in Example 5-6, explicit values or scores are placed on the impact consequence, based on a comparison of the impact outcomes with the goals for the respective impact issues. The scoring step represents, of course, a significant departure from the Balance Sheet approach in that impact outcomes are expressed in the same or commensurable units. This reduction removes the problem of trying to compare apples and oranges. A very common scoring technique that planning agencies use in the Goals Achievement approach, and one that is subject to the least criticism, is to score all outcomes on the least demanding of scales, namely an ordinal scale. The impact outcomes then would be evaluated with respect to each

5-5

lower

Example 5-5

Ranked Balance Sheet Method Applied to Alternative Interceptor Routes for South River Basin

Decision Criteria

1. The preferred alternative is that alternative whose impacts are considered to maximize the decision-maker(s) goals.

Impact Information

1. Aggregate Impacts of Interceptor Alternatives A,B,C,D,E on South River Basin (Smithville, Westville, Millville, Warwick, Avon).

Alternatives Impact Indicators	A	B	C	D	E
Visual conflicts	Slight	Slight	Moderate	Moderate	Extensive
Annual household user costs	$39	$61	$57	$65	$30
Annual household non-user costs	$17	$22	$20	$24	$15
Population increases 1960-1995 (persons)	4750	6500	3200	9000	8500
Land pre-empted (acres)	745	600	650	900	550
New manufacturing jobs	2900	3800	3000	3200	4000
Historic locations affected	17	5	13	2	31

Evaluation Results

The South River Basin Citizens Advisory Committee ranked the alternatives as follows: A >E >C >D >B

5-6 lower

Example 5-6

Scored Goals Achievement Account Applied to Alternative Interceptor Routes for South River Basin

Decision Criteria

1. *The preferred alternative is that alternative whose scored impacts are considered to maximize the explicitly-shown goals.*

Impact Information

1. *Aggregate impacts of interceptor alternatives A,B,C,D,E on South Rwver Basin, (Smithville, Westville, Warwick, Avon).*

Goals	Alternatives / Impact Indicators	A	B	C	D	E
slight	Visual conflicts	0	0	-1	-1	-2
< $40	Annual household user costs	0	-2	-2	-2	+1
< $20	Annual household non-user costs	+1	0	0	-1	+1
< 5000	Population increases 1980-1995 (persons)	0	-1	+1	-2	-2
< 500	Land pre-empted (acres)	-2	-1	-1	-2	0
> 3500	New manufacturing jobs	+1	+2	+1	+1	+2
< 10	Historic locations affected	-2	0	-2	0	-3

-3 = extensive adverse impact
-2 = moderate adverse impact
-1 = slight adverse impact
0 = negligible impact
+1 = slight beneficial impact
+2 = moderate beneficial impact
+3 = extensive beneficial impact

Evaluation Results

The South River Basin Advisory Committee feels Alternative A best maximizes their goals.

goal or objective to determine whether they increase, decrease, or leave the goals achievement about the same. Arbitrary values may be assigned, say +1 if goals achievement is enhanced, -1, if goals achievement is decreased, and 0 if there is no effect on goals achievement. An ordinal notation system of --, -, 0, +, ++ is also commonly used.

Discussion

The goals Achievement Account approach incorporates explicitly-defined goals into the decision-making process. While this is a desirable advancement over the Balance Sheet approach, it does require prior articulation of goals on the part of the decision-maker. In situations where aggregate goals and/or weights are required from a committee, this may involve considerable difficulty.

The use of ordinal scores for the impact consequences reduces the impacts to commensurable units. While this does not enable an aggregated preference score for each alternative to be developed, it does abstract the diverse impact information into a more comparable evaluation format. for some decision-makers, this may represent a loss of information. Others will view this as a necessary step to ease the decision-making task.

The selection of an alternative in the goals Achievement Account approach is similar to that in the Balance Sheet method. Alternatives may be ranked, but it is not possible to express the strength of preference. It is possible to say that Alternative A is preferred over Alternative E, but is not possible to say by how much.

5.6 COMPREHENSIVE EVALUATION TECHNIQUE: LINEAR ADDITIVE UTILITY FUNCTION

Description

The utility function evaluation method is a means of generating a single overall index of preference for an alternative that can be compared with other alternatives preference indices. This preference, expressed on an interval scale, is referred to as a linear additive utility function. It represents the aggregated weighted scores of each impact or attribute. The linear additive utility function can be mathematically expressed as:

$$u(x_{1m}, x_{2m}, \ldots x_{mm}) = W_1 v_1(x_m) + w_2 v_2(x_{2m}) + \ldots w_m v_m(x_{mm})$$

where w_m represents a weight associated with impact categories and $v_m(x_{mm})$ is the scoring (expressed on an interval scale) placed on the impact consequence. The scoring indicate the relative size or desirability of various levels of the corresponding impacts. Weights, on the other hand, represent the relative importance of a change in one impact compared to a change in another impact. The ratio of two weights, say w_{x1}/w_{x2}, represents the tradeoff that the decision-maker is willing to make in terms of how much impact x_1 he is willing to give up to gain an additional unit of impact x_2.

The end product of a Linear Additive Utility Function approach is illustrated in Example 5-7. It requires several steps:

1. Determine the score or value of each impact consequence and express on an interval scale;
2. Determine the weighting factors for each impact attribute;
3. Determine the weighted values of each impact attribute;
4. Aggregate the weighted values for each alternative;
5. Compare aggregated preferences across alternatives;
6. Select the optimal alternative, i.e., the alternative with the highest score.

Discussion

The Linear Additive Utility Function involves relatively easy computations. It also is desirable in terms of generating rankings that reflect variations in preference. In addtion, like any of the approaches that involve impact weighting, it allows decision-makers to perceive and make tradeoffs among alternatives.

On the negative side, many decision-makers will be reluctant to use an approach that involves reducing all of the impact attributes to a single index. The use of a single number to express an alternative may simply be too abstract and artificial for some decision-makers. This approach also requires the most involvement by decision-makers of any approach presented in this guidebook. Not only must weights be determined for the impacts, but much more specific and explicit scores must also be developed for the impact consequences. Thus, this approach will require a great deal of time and interaction between decision-makers and a technical planning staff.

5.7 DETERMINING A COMMUNITY PREFERENCE

Introduction

When there are multiple decision-makers involved in the evaluation process, the final step in the evaluation process must address the issue of aggregating these individual preferences into a community or committee choice. While the objective of each individual is to choose that alternative which maximizes his or her own utility, the objective in this step is to choose the alternative which maximizes social well-being. Social well-being is a function of the individual utilities of the members of the community. As the individual preferences vary according to the differing goals and priorities of the affected groups, it is unlikely that a unique alter-

5-7

Example 5-7

Linear Additive Utility Function Approach Applied to Alternative Interceptor Routes for South River Basin.

Decision Criteria

1. *The preferred alternative is that alternative which yields the highest aggregated preference score.*

Impact Information

1. *Aggregate impacts of interceptor alternatives A,B,C,D,E on South River Basin (Smithville, Westville, Warwick, Avon)*

Alternatives / *Impact Indicators*	A	B	C	D	E
Visual conflicts	*Slight*	*Slight*	*Moderate*	*Moderate*	*Extensive*
Annual household user costs	$39	$61	$57	$65	$30
Annual household non-user costs	$17	$22	$20	$24	$15
Population increases 1980-1995 (persons)	4750	6500	3200	9000	8500
Land pre-empted (acres)	745	600	650	900	550
New manufacturing jobs	2900	3800	3000	3200	4000
Historic locations affected	17	5	13	2	31

5-7

Example 5-7 (continued)

Impact Scoring

1. Impacts have been scored on the basis of the following:

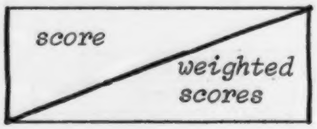
0.00 = least preferred
1.00 = most preferred

Alternatives / Impact Indicators	A	B	C	D	E
Visual conflicts	0.80	0.80	0.40	0.40	0.00
Annual household user costs	0.80	0.10	0.20	0.00	1.00
Annual household non-user costs	0.80	0.20	0.40	0.00	1.00
Population increases 1980-1995 (persons)	0.70	0.50	1.00	0.00	0.10
Land pre-empted (acres)	0.30	0.50	0.50	0.00	1.00
New manufacturing jobs	0.00	0.80	0.10	0.20	1.00
Historic locations affected	0.40	0.90	0.50	1.00	0.00

Aggregated Scores

1. Weights have been assigned on a scale of 1.0 - 15.0; weighted scores determined; and aggregated preferences determined.

2.



Example 5-7 (continued)

Weighting Factor	Alternatives Impact Indicators	A	B	C	D	E
4.0	Visual conflicts	.80 3.20	.80 3.20	.40 1.60	.40 1.60	.00 .00
15.0	Annual household user costs	.80 12.00	.10 1.50	.20 3.00	.00 .00	1.00 15.00
12.0	Annual household non-user costs	.70 8.40	.20 2.40	.40 4.80	.00 .00	1.00 12.00
10.0	Population increases, 1980-1995 (persons)	.70 7.00	.50 5.00	1.00 10.00	.00 .00	.10 1.00
1.0	Land pre-empted (acres)	.30 .30	.50 .50	.50 .50	.00 .00	1.00 1.00
12.0	New Manufacturing jobs	.00 .00	.80 9.60	.10 1.20	.20 2.40	1.00 12.00
6.0	Historic locations affected	.40 2.40	.90 5.40	.60 3.60	1.00 6.00	.00 .00
		33.30	27.60	24.78	10.00	41.00

Evaluation Results

Alternative E is the preferred alternative; the ranking of alternatives is as follows: E > A > B > C > D.

native would be simultaneously preferred by all committee members. If such were the case, the choice would be obvious. In most cases, however, selection of any particular alternative will imply that some groups benefit while others are hurt.

Reducing the Search to Pareto-Optimal Alternatives

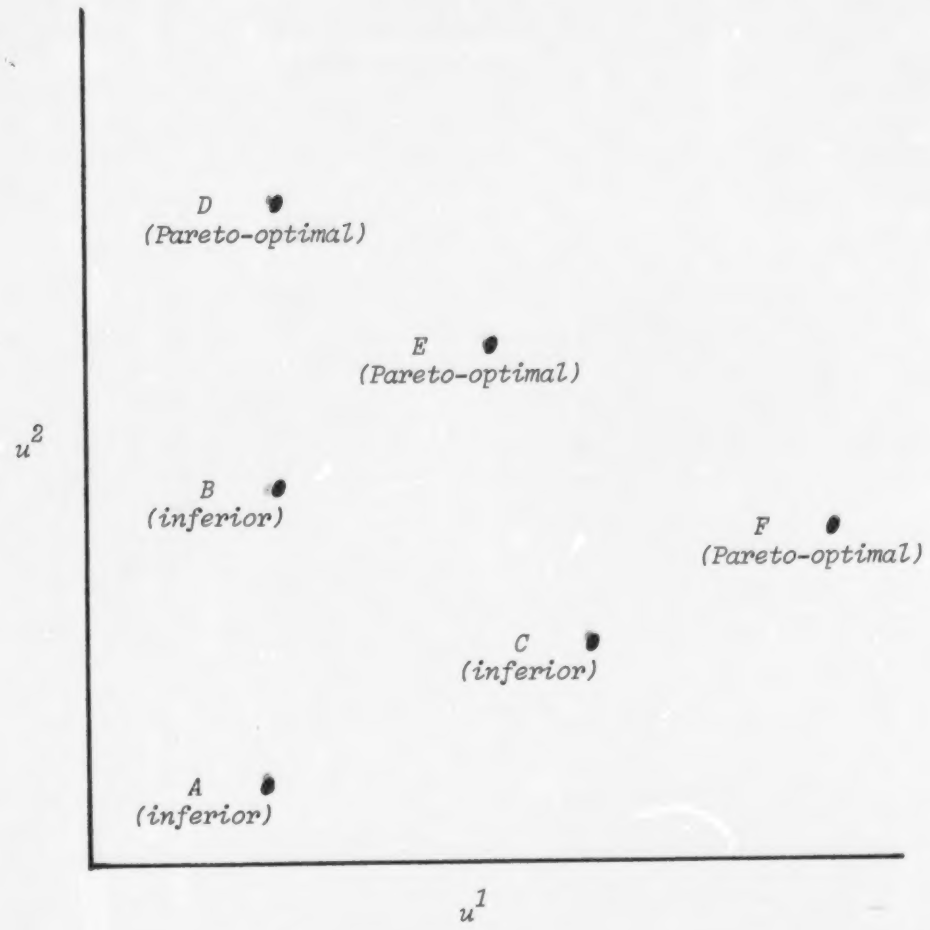
A guiding principle in the evaluation of alternative water quality management strategies should be to eliminate clutter and possible complicating factors whenever those factors will not affect the preferred final choice. Therefore, once the individual preferences of the advisory committee members have been determined, it would be desirable to screen out dominated alternatives, so that the aggregation process need only consider Pareto-optimal alternatives. The concept of Pareto-optimality is parallel to the concept of non-inferior or dominant solutions discussed earlier. Pareto-optimal solutions imply that no one individual may be better off without hurting one or more of the other individuals. Alternative p dominates alternative q if every individual feels that alternative p is just as good as alternative q, and at least one individual feels that alternative p is strictly better than alternative q. Alternative p is Pareto-optimal if there is no other alternative q, such that alternative p is dominated by alternative q. Pareto-optimal solutions are "better" than dominated solutions, from the viewpoint of collective choice, but no further differentiation may be made among Pareto-optimal solutions without preference information regarding tradeoffs among individuals.

Only ordinal individual preferences are required, as no consideration is made of the strength of preferences. In any particular case, the margin of superiority may be large or small. Alternatives are compared on each individual's particular preference scale, with no interpersonal comparison of utilities necessary. Although no single alternative is usually dominant, the choice problem may be appreciably narrowed by reducing the search to Pareto-optimal alternatives. Dominance does not imply a complete ordering on the set of alternatives, since it is not possible to compare all alternatives. In this case the search for dominance is with regard to individual preferences, while earlier the search was with regard to impact levels.

Consider the example illustrated in Example 5-8, with two individuals expressing utility functions, u^1 and u^2, respectively. Alternatives A, B, and C are dominated solutions, for the following reason: B dominates A, so A is inferior; but D dominates B, so D is also inferior; C also dominates A, but F dominates C, so C is inferior as well; in addition, E dominates B, and E also dominates C. Therefore, D, E, and F are Pareto-optimal, since there is no feasible alternative which dominates any one of them. No further choice may be made among alternatives D, E, and F without some information on the preferences for the tradeoffs among the individual utilities, as D is preferred by individual 2, but is least preferred by individual 1, among the Pareto-optimal solutions, while F is most preferred by individual 1, but is least preferred by individual 2.

Example 5-8

PARETO-OPTIMALITY



A,B,C,D,E,F = Alternatives

u^1, u^2 = individual or group preferences

The search for nondominated alternatives involves pairwise comparisons of the alternatives, say, alternative p and alternative q, with respect to individual preferences. If alternative p dominates alternative q, then alternative q is eliminated from further consideration. Likewise, if alternative q dominates alternative p, then alternative p is excluded. If neither alternative dominates the other, then both are retained and additional comparisons are made between those alternatives and the remaining alternatives. Once all pairs of alternatives have been compared in this fashion, the remaining alternatives are Pareto-optimal. Note that once an alternative has been eliminated as being dominated it need not be considered in any more comparisons. Only alternatives remaining in the set are considered in the aggregation of individual preferences.

Voting Schemes

Voting schemes refer to approaches for aggregating ordinal preferences into a community preference measure. While voting schemes are subject to shortcominings, particularly the "tyranny of the majority" problem, voting procedures are relatively easy to apply and may be appropriate for a particular water quality decision making process.

In majority voting, each individual votes for his favorite. The winner must receive at least 50% of the votes. With more than two alternatives, a majority decision is not ensured. Therefore, if no majority is reached, a modificaton of majority voting involves a runnoff election between the top two vote-getters. Depending on how the majority voting scheme is defined, however, it may be possible that the true favorite is eliminated before reaching the runoff. Another modification of majority voting in cases where a majority is not reached is to eliminate the least preferred alternative and vote again, reducing the set of alternatives and revoting until one alternative achieves a majority (eliminating inferior alternatives). In plurality voting, each individual again votes for his favorite, with the winner being that alternative which receives the largest number of votes. a majority is not required. In each of the above approaches, each individual has one vote, indicating his or her first preference.

The Cordorcet Rule states that the winner in an election is that alternative which wins by a simple majority over all other alternatives in pairwise comparisons. While the majority and plurality voting schemes only consider the first preference, the Condorcet rule does begin to examine all alternatives. Such a deicison rule is still subject to the paradox of voting and may yield intransitive results, cyclical majorities,and ambiguous outcomes. It does, however, make it more difficult for a minority candidate to win. It is also more likely to lead to a consensus than a simpler approach, as it won't leave a majority of the voters dissatisfied.

The Copeland approach again involves pairwise comparisons, but the winner need not win all of the pairwise comparisons. In this case, the winner is that alternative which wins more pairwise comparisons than any other alternative. A score is computed for each alternative which is the difference between the number of wins and the number of losses. The alternative with the highest score wins. This approach is in the spirit of the Condorcet rule. If there is no Condorcet winner, the Copeland approach chooses that alternative which can win the most pairwise comparisons. No method is completely satisfactory, but the Copeland method is recommended since in most cases it minimizes the number of dissatisfied voters.

In Borda voting, each alternative is given a score according to its rank in the preference order of each individual. The worst alternative is given a score of 0, while the best is given a score of M-1, where there are M alternatives. The second best is given a score of M-2, while the next to worse is given a score of 1, and so on. The scores of the various alternatives are then summed across individuals and the winner is that alternative with the largest total. The voting scheme reflects the entire preference order of each individual and weights the positions in each order. All preferences are incorporated, rather than only first choices or pairwise comparisons. Borda voting is not independent of irrelevant alternatives. Therefore, the results may be manipulated by excluding one or more alternatives.

Social Welfare Function

The concept of a social welfare function assumes that individual preferences are measured on an interval scale and that interpersonal comparisons of utility are possible. Because strength of individual preferences are considered, it is an appealing approach. The social welfare function approach assumes that social welfare is a function of the individual utilities. Let w_m represent the social welfare associated with alternative m, then

$$w_m = w(u_m^1, u_m^2, \ldots u_m^k)$$

where u^k is the utility of alternative m as expressed by individual k, for $k = 1, 2, {}^m \ldots k$. In general alternative p is preferred by the community to alternative q if and only if

$$w_p > w_q$$

The social welfare approach is essentially a linear additive model and requires the individuals to have weights assigned to them or determined by them. This may pose major problems for a group to determine on an interactive basis. Two hurdles are "Who sets the weights?" and "How should weights be determined?" If unequal weights are difficult to justify politically, equal weights may be used, in which case, the weight assigned to the utility of each individual is simply equal to one, or, if normalized, the inverse of the number of individuals.

5.8 SUMMARY

The preceding sections have described several activities that should take place in the impact evaluation process. While it is easy to get overwhelmed by the mechanics of each technique, a modular process should be applied. The selection of which technique to use in each module should be primarily based on the following factors:

- The techniques should be easy to use, both computationally and procedurally;
- The techniques should be comprehensible in their logic to decision-makers;
- The techniques should be capable of handling multiple-objectives;
- The techniques should be able to deal with intangible impacts;
- Decision-makers should be able to make tradeoffs.

In the discussions presented for each of the techniques, it is clear that there is no one package of techniques that maximizes all of these criteria. Clearly, decision-makers should select an approach that is appropriate to the complexity and significance of their decision-making needs. For example, the use of a linear additive utility function for impacts that have been primarily measured on an ordinal basis is not warranted.

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CHAPTER 6
Impact Mitigation

6.1 INTRODUCTION

The purpose of mitigation is to alleviate adverse socioeconomic impacts resulting from water quality control strategies. Mitigation is often given minimal attention in the assessment of water quality alternatives. Mitigation measures essentially enable adverse effects to be eliminated, minimized, or managed. by reducing or eliminating adverse impacts the planner may be able to rescue an alternative from being eliminted for further consideration. Alternatives that are attractive in terms of most of the impact categories may have one or two adverse socioeconomic impacts that may jeopardize the alternative's evaluation. By explicitly considering mitigation measures in the planning process, the adverse impacts can be mollified and thus save an otherwise acceptable alternative.

Types and examples of mitigation measures are discussed in Section 6.2. Section 6.3 discusses considerations in the selection and evaluation of mitigation measures.

6.2 TYPES OF MITIGATION MEASURES

There are basically two types of mitigation measures: those that attempt to alter or prevent the impact; and those that accept the impact and attempt to deal with it by decreasing its adversity. For the sake of classification, these two types of mitigation measures will be referred to as impact prevention measures and impact management measures respectively.

Impact Prevention Measures

Impact prevention measure primarily involve changes in the water quality control strategies themselves. Alternatives may be made in the structural controls, the implementation incentives, or the institutional arrangements. the focus of impact prevention measures is on the characteristics of the strategy that are responsible for the impact. Generic examples include reduction in the scope of the project, changes in the location of a project, alterations in the regulatory requirements, changes in the financing mechanisms, and shifts in responsibility in the institutional arrangements of a water quality strategy. Examples of impact prevention measures for growth impacts of a wastewater treatment plant are shown in Example 6-1.

Impact Management Measures

Impact management measures represent additional measures or activities to deal with expected impacts. The use of impact management measures is particularly suitable in situations where the use of impact prevention measures is not feasible or would create additional impacts. For example, consider a proposed stormwater detention pond for an existing residential neighborhood. The pond is objected to for several reasons, particularly for visual and public safety impacts. A first approach in mitigating these impacts would be to consider changes in the location or the size of the facility. Evaluation of these options might indicate, however, that the cost would be prohibitive and/or the effectiveness of the stormwater strategy would be greatly diminished. Thus, impact management measures might be more appropriate. For this particular example, safety fencing and shrub/tree plantings would be proposed and incorporated in the strategy. Other examples of impact management measures are shown in Example 6-1.

Generic types of mitigation measure appropriate for impact issues within each of the major socioeconomic impact categories being considered in this guidebook are presented in Exhibit 6-1.

6.3 SELECTION AND EVALUATION OF MITIGATION MEASURES

The selection and evaluation of mitigation measures should proceed in a manner similar to the overall evaluation of water quality strategy alternatives. Alternative mitigation measures should be generated and evaluated. It is unlikely, however, that a great number of alternative mitigation measures will be available for each impact issue. Thus the evaluation of mitigation measures should consider both impact prevention and impact management measures simultaneously. It also is advisable to consider combinations of mitigation measures involving both impact prevention and impact management.

The evaluation criteria are the same as those for regular water quality strategies except for effectiveness:

- Cost
- Effectiveness
  - Water Quality
  - Impact Mitigation

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Example 6-1

MITIGATION: IMPACT PREVENTION AND IMPACT MANAGEMENT MEASURES

Example #1

IMPACT ISSUE: *Growth impacts of wastewater treatment facilities*

IMPACT PREVENTION MEASURES:

- *Reduce the capacity of the wastewater treatment facility*
- *Reduce the capacity of the sewer interceptors*
- *Reduce service area coverage*
- *Stage the construction of interceptors*

IMPACT MANAGEMENT MEASURES:

- *Use zoning density controls to limit the amount of potential growth in service areas*
- *Use sewer tap-in fees to regulate the amount of connections*
- *Use growth management controls, such as building permit quotas and capital improvement requirements, to stage growth*
- *Use public acquisition techniques to regulate amount of land available for growth*

Example #2

IMPACT ISSUE: *Cost incidence to users of a proposed wastewater treatment facility*

IMPACT PREVENTION MEASURES:

- *Reduce scope of project*
- *Use a mix of alternative and conventional systems*
- *Alter financing mechanisms to distribute some costs to non-users*
- *Regionalize with neighboring community to get economies of scale*

IMPACT MANAGEMENT MEASURES:

- *Provide cost sharing via user's loan program*
- *Seek additional cost sharing from outside of community to lessen user burden*

Example #3

IMPACT ISSUE: *Water supply shortages resulting from population growth associated with wastewater treatment facility*

IMPACT PREVENTION MEASURES:

- *Same as those in Example #1*

IMPACT MANAGEMENT MEASURES:

- *Development of new water supply sources*
- *Water conservation measures*

Example #4

IMPACT ISSUE: *Pre-emption of valued public park land for stormwater detention lake*

IMPACT PREVENTION MEASURES:

- *Reduce scope of project*
- *Change location of project*

IMPACT MANAGEMENT MEASURES:

- *Develop multi-use recreation opportunities on the site*
- *Develop new park area to replace pre-empted one*

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Exhibit 6-1

TYPES OF MITIGATION MEASURES FOR SOCIOECONOMIC IMPACTS OF WATER QUALITY MANAGEMENT STRATEGIES

A. PUBLIC EXPENDITURES

	Impact Issues	Mitigation Measures
A-1	• Capital costs for publicly constructed projects	• Reduce scope of project • Choose less expensive alternative • Alter project timing • Seek cost sharing from other levels of government
A-2	• O+M costs for publicly operated projects	• Reduce scope of project • Alter design of project • Share responsibility with other public agency/government or with private sector
A-3	• Other management costs associated with institutional arrangements	• Reduce or alter management functions • Alter level of government responsibility for management functions • Alter public/private responsibility for management functions

B. COST INCIDENCE TO FIRMS

	Impact Issues	Mitigation Measures
B-1	• Compliance costs (capital and O+M) for privately constructed projects	• Reduce or alter requirements, standards, specifications for effected firms • Eliminate requirements for some effected interests • Eliminate geographic areas to be affected • Alter timing of requirements • Provide public cost sharing • Alter mix of economic incentives--subsidies, tax programs, charges • Provide information on other types of public and private sector financing opportunities • Provide information on alternative technologies
B-2	• Compliance costs (administrative) for programs affecting private sector	• Alter mix and type of regulatory, economic, and administrative incentives

Exhibit 6-1
(Continued)

C. EMPLOYMENT AND ECONOMIC GROWTH

	Impact Issues	Mitigation Measures
C-1	• Employment loss from existing firms affected by cost incidence	• Same as those for cost incidence (see above) • Special programs for retraining and/or placement in different jobs
C-2	• Future employment opportunities affected by public wastewater policies, growth management policies, and in-stream waste-load policies	• Alter water quality policies and programs limiting industrial constraints for moving into an area

D. COST INCIDENCE TO INDIVIDUALS

	Impact Issues	Mitigation Measures
D-1	• User and non-user costs associated with public projects and programs	• Same as those for public expenditures (see above) • Alter financing mechanisms that distribute costs • Provide public cost sharing • Provide information on other public and private sector financing opportunities
D-2	• Costs associated with property value effects	• Alter structural, location, construction, or operating characteristics of structural controls • Alter mix of implementation measures • Provide compensation

E. LAND USE/HOUSING/POPULATION

	Impact Issues	Mitigation Measures
E-1	• Scarce or valued undeveloped land pre-empted for public sector project	• Reduce or alter scope of project • Change location of project
E-2	• Private sector land pre-empted for private sector compliance requirement	• Reduce or alter requirements for affected land owners • Eliminate requirements for affected land owners • Provide information on alternative technologies

Exhibit 6-1
(Continued)

	Impact Issues	Mitigation Measures
E-3	• Existing private and public land uses affected by adjacent public or private sector structural projects	• Reduce or alter scope of project • Change location of project • Alter nuisance-producing structural, construction, or operating aspects of water quality control strategy • Provide additional buffer land or vegetation/screening
E-4	• Changes in amount, type, location, and density of various land uses	• Alter appropriate growth management strategies • Reduce or alter scope and location of wastewater facilities affecting land development capability
E-5	• Changes in rate of growth	• Alter appropriate growth management techniques • Alter timing of wastewater strategies affecting large development capability
E-6	• Changes in future housing opportunities (amount, type and location)	• Same as E-4
E-7	• Changes in future population patterns (amount, type, and location, and growth rate)	• Same as E-6

F. PUBLIC SERVICES

	Impact Issues	Mitigation Measures
F-1	• Changes in the performance or adequacy of existing public services	• Alter scope of water quality projects and programs affecting the demand for, capacity of, or service areas of affected public services • Increase performance capabilities of affected public services • Provide new service or facilities

G. RECREATIONAL ACTIVITIES

	Impact Issues	Mitigation Measures
G-1	• Changes in the adequacy of existing recreational opportunities	• Same as F-1 • Change location of projects affecting recreation site

Exhibit 6-1
(Continued)

	Impact Issues	Mitigation Measures
G-2	• Changes in physical accessibility to water-related recreational opportunities	• Reduce or alter scope of project • Change location of project • Provide new access points

H. HISTORIC RESOURCES

	Impact Issues	Mitigation Measures
H-1	• Changes in physical accessibility to historic resources	• Same as G-2
H-2	• Alteration or displacement of historic resources	• Same as H-1 • Restore affected uses
H-3	• Changes in value or importance of historic resource	• Same as H-1 • Alter nuisance producing structural, construction, or operating aspects of water quality control strategy • Provide compensation for losses • Provide additional buffer land or vegetation/screening

I. SENSORY

	Impact Issues	Mitigation Measures
I-1	• Visual nuisance impacts	• Alter nuisance producing structural, construction, or operating aspects of water quality control strategy • Provide additional buffer land
I-2	• Visual fit with setting impacts	• Reduce scope of project • Screen offending project aspects • Change location of project • Increase buffer land
I-3	• Visual compatibility/identity impacts	• Same as I-2
I-4	• Visual view and vista impacts	• Reduce scope of project • Change location of project • Provide new access points

Exhibit 6-1
(Continued)

	Impact Issues	Mitigation Measures
I-5	• Visual natural element changes	• Reduce scope of project • Change location of project • Restore affected elements
I-6	• Noise impacts from project site activities	• Alter nuisance producing structural, operating, or construction aspects of water quality strategy • Provide additional buffer land
I-7	• Noise impacts from traffic-related activities	• Change location • Reduce or alter scope of project • Provide alternative transport modes • Alter traffic patterns
I-8	• Odor impacts from project site activities	• Same as I-6

J. PUBLIC HEALTH AND SAFETY

	Impact Issues	Mitigation Measures
J-1	• Public health and safety hazards associated with water quality control strategies	• Reduce or alter scope of project • Change location of project • Provide additional measures to prevent health and safety hazards • Change hazardous or dangerous producing structural, operating or construction aspects of project • Provide contingency and back-up measures • Develop early warning monitoring measures

- Implementation Feasibility
- Impacts
  - Environmental
  - Socioeconomic

Cost

In many cases, the mitigation measures will add costs to the overall project. In particular, impact management measures are likely to involve additional costs.

Effectiveness

There are two types of effectiveness issues: water quality and impact mitigation. The imposition of the mitigation measures--particularly impact prevention measures that involve altering the scope of the project, the implementation measures, or the institutional arrangements--may diminish the effectiveness of the water quality strategy in meeting its water quality goals. This criteria should be handled simiarly to regulate water quality strategies, i.e., mitigation measures that result in reducing technical effectiveness below an acceptable level should not be considered for further evaluation.

In terms of evaluating impact mitigation effectiveness, it is important to have some understanding of how much mitigation is desirable. This "amount of adversity" may be dictated by some overriding threshhold standard, by some level of need, or whatever is the basis for the determination of significance in the impact measurement step.

It may be possible, however, to mitigate only to a certain level. This level may fall below the desired amount.

Implementation Feasibility

Like any other water quality strategy, mitigation measures may face implementation feasibility constraints. These may include legal authority problems, administrative feasibility issues, and political acceptability problems. For example, a mitigation measure for reducing growth impacts associated with wastewater treatment plants may be to alter the proposed service area for the treatment plant. This may be politically unacceptable to members of a community. Similarly, in order to alleviate the cost burden of a wastewater treatment facility on the expected users, the mitigation measure may involve shifting more of the capital costs to the community-at-large via the property tax mechanism. Again, this may have severe political ramifications and prove politically infeasible.

Impacts

Mitigation measures may stimulate new impacts or alter the magnitude and incidence of existing impacts. These impact changes have to be identified and estimated and re-entered into the socioeconomic impact profile for the alternative. For example, if additional fencing and landscaping requirements are suggested as a mitigation measure for sensory impacts associated with stormwater detention ponds, then the impact on costs and the distribution of those costs should be estimated and noted on the impact profile for the alternative.

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PART 2

IMPACT MEASUREMENT TECHNIQUES

CHAPTER 7
Public Fiscal

7.1 IMPACT DESCRIPTION

Impact Definition

This impact category is concerned with the impact of water quality control strategies on governmental expenditures and revenues. In addition, public fiscal impacts include effects on public financing ability, such as borrowing capacity. While areawide water quality strategies will often encompass public financing from many levels of government, the focus in this guidebook is on local and regional level fiscal impacts.

The public fiscal impact category represents a distribution point for many water quality strategy costs. Costs are eventually distributed to individuals and firms through a variety of public financing mechanisms including user charges, property and other taxes, and expenditure cuts in other public services. Impacts on private firms and individuals are considered in other impact categories in Chapters 8 and 10 respectively.

Impact Issues

Water quality management strategies affect expenditure and revenue patterns of local governments in a variety of ways. The direct costs associated with control strategies, such as the construction of a sewage treatment facility or a septage disposal site, raise the level of public expenditures. Indirect costs associated with increased development effects on public services may also increase public expenditures. It is also very important in this impact category to carefully consider the effects of different institutional arrangement and public financing mechanisms. Alternative public financing mechanisms will affect both the level of local public costs and the distribution of costs to private firms and individuals.

Direct Costs --

Public expenditures for water quality strategies can occur in several ways:

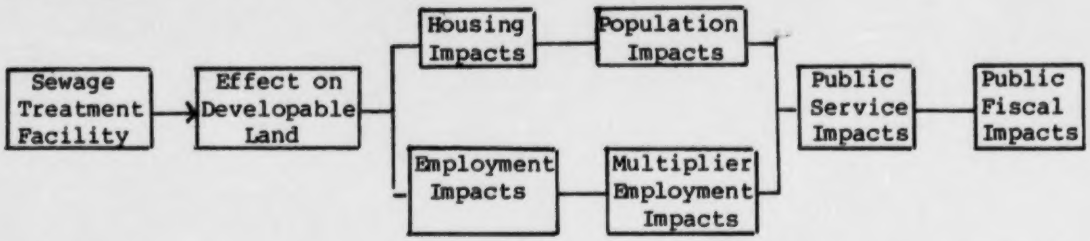
- Capital costs. If the controls involve the construction of publicly-owned facilities, facility design, construction, land acquisition, and equipment purchase costs will be incurred. The construction, expansion or upgrading of treatment works, the extension of sewer lines and infiltration/inflow corrections are some examples of water quality controls with significant capital costs. Debt service or interest costs should be included in capital costs.
- Operating and maintenance costs. These costs are incurred in the day-to-day operation of the facilities. Materials costs for chemicals, electricity, labor charges, and depreciation on buildings and equipment are typical components of O&M costs.
- Administrative and regulatory costs. The costs associated with administering, monitoring, and enforcing water quality strategies are included in this category.

This last category is often not given sufficient consideration in fiscal impact analysis in areawide water quality planning. For numerous water quality strategies, however, the major public costs will primarily include administrative and regulatory costs. On-site wastewater management strategies and urban soil erosion control strategies are two examples in which public regulatory costs may be significant.

Indirect Costs --

Water quality control strategies can affect the level of economic activity in a community. For example, regulations imposed upon construction activities and high user charges levied on industrial discharges to publicly owned treatment facilities may adversely affect businesses, resulting in decreased employment opportunities and population outmigration. This process erodes the tax base, and can leave community finances worse off than before. On the other hand, water quality control strategies may encourage business activity through multiplier and accelerator effects. These business and industrial location decisions are relatively difficult to predict in a water quality planning effort. Water quality compliance costs are only one of many factors affecting business location decisions. These impacts are discussed more fully in Chapter 9.

Changes in economic activity and population brought about by sewage treatment facilities, for example, will also affect the demand for public services which in turn may affect public expenditures and revenues. This type of indirect fiscal effect, i.e., the costs of servicing new development, has been a major focus of impact assessment, particularly on the urban fringe, in the last 10-15 years. The ability to comprehensively consider these types of fiscal impacts within areawide water quality impact assessment may be relatively difficult. The impact chain for a sewage treatment facility, for example, may look like this:



In this particular case, a sewage treatment facility increases developable land which in turn provides new housing and employment opportunities. These indirect impacts stimulate, in turn, population and additional employment impacts. Finally, additional demands on public services are translated into public fiscal impacts. The ability to quantify public fiscal impacts is directly related to the quantification of several preceding impacts. If, for example, it is not possible to quantify expected housing starts, then it will be very difficult to determine public fiscal impacts.

Institutional Arrangments--

Water quality control direct costs will obviously be affected by the size of the control strategy, but administrative and regulatory costs will also be affected by the following:

- number and type of management responsibilities
- distribution of management responsibilities.

For example, on-site wastewater management strategies may be structured with a variety of regulatory and enforcement responsibilities. The distribution of public management responsibilities may be divided according to:

- public/private sector responsibility
- type of public agency
- geographic scope of responsibility
- functional scope of responsibility

Continuing with the on-site wastewater management example, it is possible to structure a number of different public/private sector combinations of management responsibility. The amount of public cost will also be affected by the geographic scope. The on-site wastewater management agency may be set up on a sub-community special district basis or it may be set up on a regional basis. Some of the on-site wastewater management responsibilities may be shared by more than one local or regional government with different functions. The extent to which these responsibilities necessitate the start-up of new agencies or can be added to existing agencies will affect the size of public expenditures. Finally, the type of agency will affect the public financing mechanism that can be used which as discussed below may affect the level of public expenditures.

Public Financing Mechanisms--

One of the most important factors shaping public expenditures and revenues associated with water quality strategies is the type of mechanism used to finance strategies. Public financing considerations for water quality strategies may encompass a number of issues. These include equity--the distribution of costs between users and non-users; efficiency--whether each user is charged on the marginal cost of providing service; revenue adequacy--the ability of the charge structure to expand revenues as costs increase; and administrative simplicity.

The availability of outside cost sharing possibilities will also, of course, have a major influence on the size of local public fiscal impacts. The impact of different methods of public financing were summarized in Exhibit 2-4 in Chapter 2. As seen in the exhibit, private firm and private individual costs are also affected by these different methods of public financing.

7.2 IMPACT INDICATORS

The number of fiscal impact indicators is quite extensive. The use and selection of indicators will, to some extent, be related to the type of public financing mechanisms used in the water quality control strategy. For example, for capital intensive projects, a public agency will be required to finance the strategy through some type of borrowing mechanism--probably general obligation bonds or revenue bonds. Impact indicators that reflect the project's impact on a community's debt level, then, would be appropriate. Many areawide water quality strategies, however, will not involve any capital costs--only annual administrative costs, for example. In these cases, the community's indebtedness is not of concern.

The indicators discussed below do not include household or individual user indicators as these are discussed in Chapter 9, Individual Costs/Benefits. Since fiscal impacts only represent a distribution point for many cost impacts, the presentation of individual cost impact indicators with fiscal impact indicators in the assessment process is suggested.

Suggested fiscal impact indicator types are as follows.

- Changes in Annual Water Quality Costs
- Changes in Overall Debt Characteristics

- Changes in Tax Rate
- Changes in Tax Base
- Changes in Other Public Service Costs

Each of these types of impact indicators is discussed further below.

Changes in Annual Water Quality Costs

In this category, costs associated with a water quality strategy may be expressed relative to existing water quality costs. These costs may be expressed in total terms or broken down by type of costs--capital costs, operation and maintenance costs, and administrative costs. They may also be broken down by agency observing the costs. Examples include:

- Percent increase in annual erosion control costs
- Percent increase in annual Planning Board stormwater management control costs
- Percent increase in annual sewer costs
- Percent increase in annual sewer operation and maintenance costs

Water quality costs may also be expressed in relation to overall local costs. For example, it may be useful to express local sewer costs as follows:

- Increase in ratio of total annual sewer/costs total annual local annual operating costs

In general, this indicator type is the least difficult to develop and express. However, it also provides relatively little information on fiscal impact compared to other impact indicators.

Changes in Overall Debt Characteristics

For water quality strategies involving capital costs, some type of borrowing through the issuance of bonds, may have to be used to finance capital costs. The following debt indicators are useful for expressing water quality fiscal impacts:

- Percent increases in total debt
- Percent increases in net debt
- Increase in ratio of net debt/full taxable market value

- Percent increase in debt service costs

- Changes in bond rating

It is useful to distinguish between net and total debt. Net debt is equal to general obligation debt (tax-supported) minus revenue bond debt that is self supporting. Tax-supported is debt that is repaid from the general taxes of a jurisdiction--it is backed by its full taxing power. Both general obligation bonds and revenue bonds are likely to be sources of capital cost financing for water quality projects. Net debt may be particularly relevant because of the legal ceiling limitation placed on debt in many states.

The ratio of debt/taxable market values and debt service costs are particularly useful indicators generally considered to be important by bankers and investment houses, such as Moodys and Standard & Poor's. The latter firms are responsible for issuing municipal bond ratings that influence interest rates that proposed bonds will have to bear. In some cases, the necessity to incur a substantial amount of new debt, such as that required for new wastewater facilities, will be significant enough to alter a community's bond rating (i.e., credit capacity).

All of the indicators in this category are useful indicators to reflect the fiscal impact of direct capital costs associated with water quality projects and indirect capital costs associated with other public service requirements.

Changes in Tax Rate

Those local wastewater costs not directly paid by users will be borne by the taxpayers of a community as a whole. Changes in the tax rate are useful in portraying overall local fiscal impact and individual burdens. A community's wastewater costs or other public service costs--whether they be operating and administrative costs or capital costs, (annual debt service costs) will be ultimately reflected in the tax rate. Typical indicators are the following:

- Absolute increase in the tax rate

- Percent increase in the tax rate

Changes in Tax Base

This indicator is most useful for expressing indirect fiscal impacts resulting from gains and losses in population or employment base. Example indicators include the following:

- Absolute increases in the total assessed property valuation

- Percent increases or decrease in the total assessed property valuation

Changes in Other Public Services Costs

In the Public Services impact category in Chapter 12, costs may be generated for particular public service impacts that result indirectly from water quality strategies. It may be useful to express these fiscal impacts in a manner similar to changes in water quality costs. Examples include:

- Percent or absolute increase in annual school costs
- Increase in ratio of annual school costs/total annual local jurisdiction's operating costs

7.3 PRELIMINARY CONSIDERATIONS

A key consideration prior to measuring fiscal impacts is the required level and scope of effort in this impact category. As mentioned in Section 7.1, a number of fiscal impacts encompassing tax base changes and other public service costs may be triggered by population and employment-related impacts. Obviously, these indirect impacts have to be determined prior to attempting to define for a particular water quality strategy the full range of fiscal impacts.

A second and less involved consideration that should be made involves the type of costs and financing being used in the water quality strategy. Specifically, if there are no capital costs involved with a particular strategy or if no form of debt financing is being used, then the need to develop information and indicators on debt characteristics is not necessary.

7.4 MEASUREMENT TECHNIQUES

The first step in determining local fiscal impacts, if not already determined in the cost analysis for the water quality strategy, is to compute the "local share". The local share is equal to total costs less federal and state shares and other local shares (for example, in a regional project). The "local share" may be used for a local government or special district. See Example 7-1 for an example of calculating the local share for the community of Smithville. Once the local share for relevant capital, operation and maintenance, and administrative costs have been determined, it is possible to measure specific fiscal impact indicators.

Changes in Annual Water Quality Costs

This indicator category merely requires the development of percentage increases using the following ratio:

$$\frac{\text{PROJECTED COSTS-EXISTING COSTS}}{\text{EXISTING COSTS}}$$

Examples are shown in Example 7-2. This indicator category may also

EXAMPLE 7-1

TOTAL WATER QUALITY CAPITAL COSTS/"LOCAL" COSTS

(.4 mgd plant and interceptors to serve town of Smithville)

Description	Total Cost	Cost Breakdown		Eligible Cost Breakdown			Total Cost to Smithville
		Eligible Cost	Noneligible Cost	State Share	Federal Share	Local Share	
Step I - Engineering fees	$ 14,700	$ 14,700	$ -	$ 2,200	$ 11,050	$ 1,450	$ 1,450
Step II							
1. Survey and borings	20,800	18,550	2,250	2,800	13,900	1,850	4,100
2. Engineering fees for sewer design	45,550	45,550	-	6,850	34,200	4,500	4,500
Step II - Subtotal	$ 66,350	$ 64,100	$ 2,250	$ 9,650	$ 48,100	$ 6,350	$ 8,600
Step III							
1. Construction cost contract 77-1	$790,950	$749,950	$41,000	$112,500	$562,450	$75,000	$116,000
2. Engineering fees contract 77-1	72,400	65,150	7,250	9,800	48,850	6,500	13,750
3. Easements and legal fees	23,600	-	23,600	-	-	-	23,600
Step III - Subtotal	$886,950	$815,100	$71,850	$122,300	$611,300	$81,500	$153,350
Total Project Cost	$968,000	$893,900	$74,100	$134,150	$670,450	$89,300	$163,400

7-2

EXAMPLE 7-2

CHANGES IN ANNUAL WATER QUALITY COSTS

Example 7-2A

Existing 1980 Smithville Annual Erosion Control Regulatory Costs: $35,000

Proposed 1985 costs: $48,000

Proposed 1990 costs: $63,000

Proposed 2000 costs: $78,000

Impact: 37% increase by 1985 in annual costs
80% increase by 1990 in annual costs
123% increase by 2000 in annual costs

Example 7-2B

Existing 1980 total annual sewer costs: $345,000

Existing 1980 Smithville total annual operating budget: $6,530,000

Proposed total annual sewer costs in 1985: $791,000

Projected total Smithville total annual operating budget: $8,500,000

Impact: Ratio of Smithville annual sewer costs/operating budget will increase from .05 in 1980 to .09 in 1985.

use comparative ratios to express impacts. This simply involves dividing the relevant water quality cost by a base such as total annual local government operating costs. Examples are shown in Example 7-2 also.

Changes in Overall Debt Characteristics

Except for changes in bond ratings, the indicators in this indicator category are derived similarly to those in the above indicator category. One problem encountered in this indicator category may involve the calculation of full market value of local property. In most communities, full market value of property is not kept up to date and only assessed valuation is shown on the property tax rolls. The analyst then will be required to determine the equalized or full market value fro published figures from the State Office of Taxation or an approximate conversion figure from the local tax assessor. For example, the local tax asessor may be able to say that property is assessed "at approximately 45% of full market value."

The determination of annual debt service costs for a particular water quality strategy involving capital costs, if not provided by the engineer, will require some minor calculation on the part of the water quality agency. If the size of the debt, the interest rate, and maturity date are available, then the analyst can calculate annual debt service cost of the debt from a standard book of financial tables, under the heading Annual Payment or Installment to Amortize $1 or $1000. A debt service cost example is shown in Example 7-3.

The interest rate depends on the general level of interest rates and on the local credit rating. For the purposes of available water quality planning, it is not necessary to determine the exact interest rate likely to be obtained on a particular capital cost.

Example 7-3

DEBT SERVICE COST CALCULATION

Assuming that the debt is $5,000,000, the interest rate is 7% and the term is 20 years; use a compound interest table or amoritization table that shows annual payments necessary to amortize a $1 or $1000 debt. Find the page with 7% interest, then look under 20 years at 7% interest. In this particular case, a factor of 0.094393 is given to amortize a $1 loan. Then simply multiply the factor by the amount of debt as shown below:

$5,000,000 x 0.094393 = $471,965 = annual average debt service

(Note: if the table is for a $1 debt, multiply the factor times the full amount of the debt. If the table is for a $1000 debt, multiply the factor times the debt in thousands -- $5 million equals $5,000.)

This method yields an annual average amount and not a precise figure since principal payments are scheduled in specific amounts, the interest will vary accordingly. The above method, however, using standard amortization tables, will produce a reasonably accurate estimate of annual debt service.

The local treasurer in a community or a local financial analyst can be consulted or an approximation can be made by the water quality planner using current interest rates levied in comparable situations.

Maturity, or debt term, is the number of years required to repay the debt. This will generally be based on the expected life of the water quality strategy capital item. It will also depend, in the case of revenue bonds, on the annual revenues projected for the project. In the case of general obligation bonds, it will depend on the general financial capacity of the jurisdiction, including the existing debt repayment schedules of the jurisdiction.

The last indicator in this category--change in bond rating or credit capacity--is a useful indicator to measure if a particular well-developed project is being considered. The analysis necessary to make a judgement about bond rating changes is likely to be beyond the needs of impact assessment for areawide water quality assessment. In any case, a comprehensive screening procedure useful for bond rating analysis and for determining if a community can afford a propoed project has been developed by EPA in accordance with Program Guidance Memo 79-8. This screening procedure is presented in Appendix C.

Changes in Tax Rate

The procedures for determining changes in the tax rate are straightforward. There are two types of expenditures that may be reflected in the tax rate: 1) direct water quality strategy costs (such as, debt service costs, operation and maintenance costs, and administrative and regulatory costs); and 2) other public service costs resulting from indirect population and employment effects. The latter category is much more difficult to predict and the water quality planner may only want to reflect fairly reliable estimates in tax rate change calculations.

A methodological hurdle that confronts tax rate change analysis for either of the above cost categories is the problem of changing tax base. For example, if annualized wastewater costs are projected for, say a 10 year period, actual tax rate effects resulting for wastewater costs during that period will depend on tax base changes. It may be relatively difficult to predict a jurisdiction's expected tax base 10 years from now unless the jurisdiction has developed a fiscal impact model. A traditional solution is to simply extrapolate the existing tax base using a projected growth rate. A problem with any tax base projections, however, is the change in actual market value of the tax base over time. The impacts of tax rate change beyond five years are difficult to predict. Thus, a common approach in presenting tax rate change impacts is to simply calculate the expected change for only the current or next year. See Example 7-4.

7-4

EXAMPLE 7-4

TAX RATE CHANGE CALCULATION
FOR SMITHVILLE SEWERAGE FACILITIES

Project Costs: 1981 Debt Service Costs = $450,000

1981 O + M Costs = $ 90,000

1981 Total Sewer Costs = $540,000

Amount financed through user charges = $380,000

Amount financed through property taxes = $540,000-380,000 = $160,000

Amount currently financed through property taxes = $ 50,000

Projected tax revenue income needed = $160,000-50,000 = $110,000

Current property valuation (Tax Base) = $35,000,000

Current tax rate/$1000 valuation = $56/$1000 valuation

Current tax rate revenue generated = $35,000,000 x 56 = $1,960,000

Total tax revenue needed in 1981 to meet existing operating costs and new sewer costs

$$= \begin{array}{r} \$1,960,000 \\ \underline{110,000} \\ \$2,070,000 \end{array}$$

Required tax rate to meet additional sewer revenue needs:

$$= \frac{\$1,960,000}{2,070,000} = \frac{56}{X}$$

= $59.14

1981 Tax Rate increase due to additional sewer costs:

= $59.14 - 56 = $3.14 = 5.6% increase

Changes in Tax Base

This category of fiscal impacts is largely concerned with tax base changes resulting from indirect land use effects--particularly from housing and employment effects. This may be a potentially interesting issue in a jurisdiction since a claim often used to promote the implementation or expansion of a public sewage system is accelerated or increased commercial and industrial development.

The input for determining tax base changes associated with indirect development will come from housing and employment impacts shown in the impact chain in Section 7.1. Thus, the number of housing units attributable to the water quality strategy may be translated into assessed valuation figures using average house valuation figures from the tax assessor's office. Since this development will occur over time, it will be necessary to make inflationary adjustments to the average valuation figures at certain time intervals. For commercial and industrial impacts, employment/valuation ratios can be developed using recent local examples. These can be applied to the employment impacts to determine their contribution to tax base changes.

An additional tax base issue that may need to be calculated is the decrease in tax base resulting from the conversion of private land to public land for a water quality strategy. A land application system, for example, may comprise a few hundred acres. These conversions should be determined in the land use impact category. The tax base losses can be obtained directly from the tax assessor's losses.

Changes in Other Revenues

Changes in property tax revenues are, of course, only part of the change on the revenue side of local finances. Although property tax and tax base generally represent the most aspects of local revenues, increasingly localities are depending on a more diversified revenue picture. The principal sources of local revenue include:

Own Sources	● Taxes: real and personal property; income; sales; and other miscellaneous areas. ● Changes/Miscellaneous Revenues: fees and permit revenue; interest earnings; fines, etc.
Intergovernmental Transfers	● State: Sales and income tax redistribution; motor funds tax; cigarette and alcohol tax; educational and other categorical assistance. ● Federal: Revenue sharing; block grants; categorical assistance, etc.

Many of the intergovernmental transfer sources are geared to population multipliers and formulas. Thus, you should take expected population changes to the local finance officer in a community to see how these revenue formulas might changes with a given change in population.

You will be able to calculate fairly easily changes in fees and revenues associated with utilities. See Example 7-5. In terms of other miscellaneous charges, you should use per capita estimates. For example, municipalities levy use charges for a variety of items -- school lunches to use of public buildings. Take the annual revenues from these typical miscellaneous revenues and divide by the population to determine per capita revenue from user charges. Use this latter figure to multiply by population changes to calculate revenue from these sources attributable to new growth.

Changes in Other Public Service Costs

Costs determined in Chapter 12 for public service impacts may be expressed in a manner similar to water quality costs, i.e., in percentage change terms on comparative ratios as shown in Example 7-2. Public service costs associated with indirect population growth may be compared for a particular project, such as wastewater treatment facility, with changes in revenue. This comparison, known as cost-revenue analysis, is used by many communities to evaluate the fiscal impact of new development. Chapter 12 presents several techniques for estimating the "cost side" of new development.

7.5 DATA REQUIREMENTS

The most important data consideration in this impact category concerns the "local share" of water quality strategy costs. This information should be developed in conjunction with the water quality strategy prior to impact assessment. If the local share for particular water quality strategies has not been determined, then the first step in this fiscal impact analysis will be to derive these figures if possible.

As seen in Exhibit 7-1 most of the other data required in this impact category should be readily available from local secondary sources or local government officials.

115

Example 7-5

REVENUE CALCULATION FOR FEES ASSOCIATED WITH WATER FOR NEW GROWTH

Population Increment: 5000 people

Existing Average Daily Water Consumption: 85 gallons per person

Total Annual Water Consumption: 85 gal./person x 5,000 people x 365 days per year = 155,125,000 gallons

Water Rate: $1.75/1000 gal./household plus $.50/1000 gallons

Water Revenues:

Portion A (1st 1000 gallons for each household)

- 5000 ÷ 3.5 (household size) = 1429 homes
- 1429 homes x $1.75 = $2,501

Portion B (Excess amount)

- 155,125,000 - 1,429,000 = 153,696,000
- $\frac{153{,}696{,}000 \times \$.50}{1{,}000} = \$76{,}848$

Total Water Revenue: $2,501 + $76,848 = $79,349

Exhibit 7-1

PUBLIC FISCAL DATA SOURCES

Data Item	Data Source	Use
- Local share of water quality costs	• Water quality strategy cost analysis	Changes in Annual water quality costs
- Existing water quality costs	• Local annual report	
	• Appropriate local water quality agency	Changes in annual water quality costs
- Full market value of local property	• State Taxation Office • Local Tax Assessor Estimate	Changes in debt characteristics; changes in tax base
- Existing debt service costs	• Local annual report	Same as above
- Local interest rate for municipal bonds	• Local treasurer	Same as above
- Local bond rating	• Local treasurer	Same as above
- Existing tax rate	• Local Tax Assessor	Changes in tax rate
- Housing and employment impacts	• Land use (Chapter 11) and Employment (Chapter 9) Impact Categories	Changes in tax base
- Other public service costs	• Other Public Services Impact Category (Chapter 12)	All indicator measurements except water quality cost changes
- Existing local operating budget breakdown	• Local annual report • Latest U.S. Census of Governments, *Governmental Finances: Finances of Municipalities and Township Governments*, Bureau of the Census	Changes in water quality costs; changes in other public service

7.6 REFERENCES

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Municipal Finance Officers Association. Debt Financing of the State and Local Share of Constructing Municipal Wastewater Treatment Facilities. Prepared for EPA. July, 1978.

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Real Estate Research Corporation. The Costs of Sprawl: Detailed Cost Analysis. Prepared for EPA, CEQ, HUD. April, 1974.

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CHAPTER 8
Private Firm Costs

8.1 IMPACT DESCRIPTION

Impact Definition

The implementation of water quality strategies will affect many regional and local firms in the planning area. Of concern in this impact category are the direct water quality compliance costs and benefits for firms. Two types of firms are of particular interest: businesses that discharge sanitary or industrial wastewater directly to a water body or to a municipal sewage treatment plant; and agricultural producers.

This impact category, like the fiscal impact category, serves as a distibution point for cost impacts. In virtually every case, over the long run, the water quality control costs are passed on to the consumer as price adjustments. To the extent that firms succeed in passing these costs along, they shift part of the cost burden to the consumer. For the most part these consumer costs are not of concern in this guidebook because of the difficulty in assessing them at the local and regional level. One consumer cost impact that is discussed in Chapter 11, however, is the effect of land development water quality compliance costs on housing costs.

Impact Issues

New or additional costs to firms result from charges, fees, and other expenses of complying with water pollution control regulations. These costs may result from maintaining a pretreatment facility, maintaining a stormwater source control program, or paying user charges and Industrial Cost Recovery (ICR) payments to the municipal wastewater treatment facility. A firm may also face tax increases or special assessments as the result of public costs of water pollution control. For example, a community that is constructing a new sewage treatment facility may fund a portion of its capital costs from property taxes or front-footage assessments because of the benefits that theoretically occur to everybody in a community that has public sewerage, and because of the benefits that accrue to properties that are served or have access to public sewerage. Land intensive firms, such as farms, may not even be tied into the public sewerage but may pay a substantial share of public wastewater costs if property taxes and front-footage assessments are part of the public financing mechanisms.

As in the case of differences among industries, the impact of water pollution abatement requirements on individual firms--and particuarly individual plants--will be markedly dissimilar. This is the result of several interrelated factors, including:

- Efficiency--An efficient plant is likely to encourage pollution abatement investment by its owners.
- Plant size and age--These are often good indicators of efficiency. Because there are substantial economies of scale to most pollution abatement processes, per unit abatement costs for larger plants are less than for small plants.
- Firm size--Larger firms often have better access to capital markets, and can thereby secure more favorable terms in acquiring the capital required for abatement investments. Larger firms generally have more flexible capital structures and can more readily shift capital on an intra- or inter-plant basis. Also, larger firms generally are required by investors and/or creditors to earn a smaller return on capital than smaller firms to qualify for the same interest rate on borrowed capital. This is a direct result of the perceived risk factor in investing in smaller firms.
- Market position--Much of the increased investment required for pollution abatement will be reflected in price changes. How much of the increased cost can be passed on to the consumer will depend on the demand for a firm's product and the position of that firm in the industry.
- Profitability--Firms with higher profitability generally have better access to capital markets.
- Capital structure--Firms currently characterized by higher debt burdens than the average for their industrial sector generally can acquire needed capital only on less favorable terms.
- Production processes--Some production processes are inherently less polluting and, therefore, require smaller investments to meet abatement standards.

The degree to which a firm can successfully shift its increased costs varies most directly with the position of the firm in its product markets. The extent to which a firm can control its costs or charges through market pressure will also dictate the degree to which it may pass along water quality control costs. For example, if the firm has oligopolistic control (where there is little competition among sellers) of its product markets, it may be able to pass along most of its increased costs. On the other hand, where there is much competition among sellers and prices are crucial, a unilateral price increase due to pollution control may be implausible if the firm wants to stay in business. By the same token, the firm may be able to control the prices it must pay for other production factors.

The distribution of these costs between O&M (operating and maintenance) and capital cost may also have an impact on the degree to which firms must recover their increased costs. Tax laws, such as rapid amortization, low-cost loans or other capital subsidies may reduce the net cost to the firm for capital equipment, thereby decreasing its need to pass along increased pollution control costs resulting from capital equipment expenditures. The existence of such incentives may influence firms to tradeoff increasd capital expenditures for decreased O&M costs, where such a tradeoff is feasible.

Firms that find it difficult to pass along pollution control costs may choose other alternative actions in response to these costs. One of the available options may be to alter the method of production. Changes in production method may, in certain instances, reduce the firm's pollutant output directly, by changing a firm's effluent volume and/or characteristics. This may result in a reduction in the firm's pollution control costs. Changes in the method of production may also bring about changes in the firm's employment profile since new methods may be more or less labor intensive or may require different skill mixes. A firm may alter the quality or type of raw materials it purchases in order to offset increased costs. For example, a firm may use less metal and more of cheaper substitutes, such as plastic, in its products. Of course, such input changes may have an effect on gross sales.

Generally speaking, the firm faced with increased costs from water pollution control will choose some combination of the above approaches to cover these costs. It may, for example, raise prices for its finished products, alter its method of production for these products, lay off workers to accommodate pollution abatement expenses, attempt to increase productivity and/or increase market share.

Where, for one reason or another, a firm can neither pass its increased costs to the consumer nor absorb them, it is faced with one long run alternative, it must go out of business. However, where increased pollution costs contribute to a decision to close a firm, other considerations are also present that prompt the firm's failure. For example, a firm may have a plant that is marginally profitable due to obsolete equipment. If the firm cannot pass along its pollution control costs and cannot finance modernizing the plant, it may be forced to cease production. Many firms that cite pollution control costs as the immediate reason for shutting down would have shut down within a short time as a result of competitive market pressures.

A further impact on the firm resulting from pollution control costs is the relation of magnitude of the control cost at its current location to costs in other regions of the country. In other words, areas where firms do not have to pay large water quality control costs may attract industry from areas where these costs are higher. By the same token, an area may lose industry to a competing region with lower wastewater pollution control expenses costs. While few firms move from an area due to pollution control expenses alone, these costs may influence a firm looking for an area to locate or relocate a plant. This movement is called accelerator growth and is fully discussed in Chapter 9, Employment and Economic Growth.

Impact Issues: Agricultural Producers

Water quality control strategies for agricultural producers, as outlined in Appendix A of this guidebook, may place a variety of restrictions on agricultural production methods or may require the implementation of specific physical pollution control activities. Alternative production methods, also referred to as best management practices, include altered planting periods, different crops, or altered location of activities on a farm. Physical actions may include livestock waste storage areas or erosion control terraces. The principal agricultural non-point sources addressed by local and areawide water quality strategies are the following:

- soil erosion
- fertilizer runoff/seepage
- pesticide runoff/seepage
- livestock water runoff/seepage

The individual farmer has been concerned about soil erosion for many years--mostly because of agricultural productivity reasons, however, rather than due to water quality concerns. There have been a a number of Federal and state programs designed to assist the farmer in controlling erosion, including cost sharing programs, technical assistance, loans, and tax credits. These incentives have been traditionally offered to encourage the farmer to participate in soil erosion control programs and to equalize economic impacts among farmers.

The increased controls represented by water quality strategies represent additional compliance costs for some farmers. Other farmers may not be affected at all by restrictions because of their current agricultural practices. The water quality compliance costs for affected farmers may be considered as an additional production cost as shown in Exhibit 8-1 (See item 8).

If the proposed water quality practices require new production methods, then yields and therefore income may be affected. The affects on income are also, of course, highly infuenced by the particular agricultural market and by the existing productivity of the farm. As with industrial and commercial firms, the ultimate impact of higher production costs will depend on the nature of the demand for the farmer's products, i.e., the ability of farmers to pass increased costs along to the consumer. Where yield is affected by water quality cost impositions, then more productive farms will benefit over less productive ones. Thus, under reasonably uniform water quality restrictions, farms in highly productive areas would benefit relative to farms in less productive areas.

It should also be noted that the imposition of pollution control requirements on agricultural practices may produce individual farm benefits. These positive aspects will have to be emphasized by implementing agencies. On-farm benefits may include the following:

- reduced erosion and loss of productive land;
- efficient use of costly nutrients and pesticides;
- increased water retention in certain fields and thus reduction of a portion of production costs.

8.2 IMPACT INDICATORS

Industrial and Commercial Firms

There are three types of issues that are important in considering impact indicators for this impact category:

- types of compliance costs;
- types of firms affected by pollution abatement requirements;
- amount of compliance burden.

Types of compliance costs may be broken down by type of action required, such as sewer charges, erosion control, pretreatment; or by type of cost, such as operation and maintenance costs, or annual costs. Types of firms may encompass a number of classifications depending on the level of Standard Industrial Classification (SIC) code used. See Exhibit 8-2 for a portion of the Standard Industrial Classification Manual: 1972 published by the Office of Management and Budget. It is also possible within this indicator to indicate actual firms affected. Amount of compliance burden in its simplest form may indicate the amount of annual or capital pollution control costs. There are a number of ratios, however, that more precisely

Exhibit 8-1

MAJOR FACTORS AFFECTING FARMER'S SELECTION OF WATER QUALITY CONTROL OPTION

A. GROSS REVENUE:

1. Expected Prices
2. Expected Production

Gross Revenue = (1 X 2)

B. PRODUCTION COSTS BY OPERATION:

1. Land Charge
2. Tillage
   - Labor
   - Equipment
   - Fuel
   - Interest
   - Scheduling
3. Fertilization
   - Labor
   - Equipment
   - Fuel
   - Fertilizer
   - Interest
   - Scheduling
4. Pest Control
   - Labor
   - Equipment
   - Fuel
   - Pesticides
   - Interest
   - Scheduling
5. Planting
   - Labor
   - Equipment
   - Fuel
   - Seed
   - Interest
   - Scheduling
6. Harvesting
   - Labor
   - Equipment
   - Fuel
   - Interest
   - Scheduling
7. Storage and Transport
   - Labor
   - Equipment & Facilities
   - Fuel
   - Interest
   - Scheduling
8. Pollution Control Practice Design, Construction, Installation, Operation & Maintenance
   - Labor
   - Equipment
   - Fuel
   - Interest
   - Scheduling

TOTAL PRODUCTION COSTS = 1+2+3+4+5+6+7+8

NET REVENUE = (Gross Revenue - Total Production Costs)

C. OTHER FACTORS (Risk, Uncertainty, Attitudes, Preferences, etc.)

Source: U.S. Department of Agriculture, Agricultural Research Service, *Control of Water Pollution from Cropland, Volume I: A Manual for Guideline Development*, prepared for U.S. Environmental Protection Agency, EPA-600/2-75-026a, November 1975.

Exhibit 8-2

A PORTION OF THE STANDARD INDUSTRIAL CLASSIFICATION MANUAL: 1972

Code	*Short Title*
29	PETROLEUM AND COAL PRODUCTS
291	Petroleum Refining
2911	Petroleum refining
295	Paving and Roofing Materials
2951	Paving mixtures and blocks
2952	Asphalt felts and coatings
299	Misc. Petroleum and Coal Products
2992	Lubricating oils and greases
2999	Petroleum and coal products, nec
30	RUBBER AND MISC. PLASTICS PRODUCTS
301	Tires and Inner Tubes
3011	Tires and inner tubes
302	Rubber and Plastics Footwear
3021	Rubber and plastics footwear
303	Reclaimed Rubber
3031	Reclaimed rubber
304	Rubber and Plastics Hose and Belting
3041	Rubber and plastics hose and belting
306	Fabricated Rubber Products, nec
3069	Fabricated rubber products, nec
307	Miscellaneous Plastics Products
3079	Miscellaneous plastics products
31	LEATHER AND LEATHER PRODUCTS
311	Leather Tanning and Finishing
3111	Leather tanning and finishing
313	Boot and Shoe Cut Stock and Findings
3131	Boot and shoe cut stock and findings
314	Footwear, Except Rubber
3142	House slippers
3143	Men's footwear, except athletic
3144	Women's footwear, except athletic
3149	Footwear, except rubber, nec
315	Leather Gloves and Mittens
3151	Leather gloves and mittens
316	Luggage
3161	Luggage
317	Handbags and Personal Leather Goods
3171	Women's handbags and purses
3172	Personal leather goods, nec
319	Leather Goods, nec
3199	Leather goods, nec
32	STONE, CLAY, AND GLASS PRODUCTS
321	Flat Glass
3211	Flat glass
322	Glass and Glassware, Pressed or Blown
3221	Glass containers
3229	Pressed and blown glass, nec
323	Products of Purchased Glass
3231	Products of purchased glass
324	Cement, Hydraulic
3241	Cement, hydraulic
325	Structural Clay Products
3251	Brick and structural clay tile
3253	Ceramic wall and floor tile
3255	Clay refractories
3259	Structural clay products, nec
326	Pottery and Related Products
3261	Vitreous plumbing fixtures
3262	Vitreous china food utensils
3263	Fine earthenware food utensils
3264	Porcelain electrical supplies
3269	Pottery products, nec
327	Concrete, Gypsum, and Plaster Products
3271	Concrete block and brick
3272	Concrete products, nec
3273	Ready-mixed concrete
3274	Lime
3275	Gypsum products
328	Cut Stone and Stone Products
3281	Cut stone and stone products
329	Misc. Nonmetallic Mineral Products
3291	Abrasive products
3292	Asbestos products
3293	Gaskets, packing and sealing devices
3295	Minerals, ground or treated
3296	Mineral wool
3297	Nonclay refractories
3299	Nonmetallic mineral products, nec
33	PRIMARY METAL INDUSTRIES
331	Blast Furnace and Basic Steel Products
3312	Blast furnaces and steel mills
3313	Electrometallurgical products
3315	Steel wire and related products
3316	Cold finishing of steel shapes
3317	Steel pipe and tubes
332	Iron and Steel Foundries
3321	Gray iron foundries
3322	Malleable iron foundries
3324	Steel investment foundries
3325	Steel foundries, nec
333	Primary Nonferrous Metals
3331	Primary copper
3332	Primary lead
3333	Primary zinc
3334	Primary aluminum
3339	Primary nonferrous metals, nec
334	Secondary Nonferrous Metals
3341	Secondary nonferrous metals
335	Nonferrous Rolling and Drawing
3351	Copper rolling and drawing
3353	Aluminum sheet, plate, and foil
3354	Aluminum extruded products
3355	Aluminum rolling and drawing, nec
3356	Nonferrous rolling and drawing, nec
3357	Nonferrous wire drawing & insulating
336	Nonferrous Foundries
3361	Aluminum foundries
3362	Brass, bronze, and copper foundries

indicate individual firm burden, such as the following: annual costs as a percentage of gross sales; pollution control investment as a percentage of fair market value of capital stock.

Impact indicators, then, may be structured around the above types in various combinations, including the following examples:

- annual sewer user charges in $/gallon;
- number of electroplating firms affected by pretreatment costs;
- annual pretreatment costs/gross sales for XYZ Jewelry Company.

Agricultural Producers

Similar to industrial and commercial firms, cost incidence indicators for agricultural producers may be categorized into three types:

- type of compliance costs;
- types of farms or agricultural activity affected by pollution abatement requirements;
- amount of compliance burden.

The types of compliance costs may be classified by soil erosion costs, fertilizer and pesticide control costs, and livestock waste costs. These may also be expressed in operation and maintenance terms, capital costs, or annual costs. Types of agricultural activity may be broken down by types of farms, such as livestock, poultry, and type of crops. Size of farms affected may also be a useful indicator here as well, such as farms smaller than 100 acres or farms with gross income less than $100,000/year. Annual pollution abatement costs as a percentage of annual production costs; annual pollution abatement costs as a percentage of annual gross income; per acre compliance costs; and changes in yield/acre are all useful indicators of agricultural compliance burdens.

Indicators can be developed that incorporate one or more of these three types of indicators, such as the following examples:

- average annual soil erosion costs for South River watershed farms;
- average soil erosion capital costs/acre for non-producing farms;
- decrease in bushels of wheat/acre yield due to fertilizer controls.

8.3 PRELIMINARY CONSIDERATIONS

There are a number of issues affecting the type of analysis and the level of effort in this impact category.

Regulatory Issues

Two water quality strategies, namely EPA pretreatment regulations and Industrial Cost Receiving (ICR) provisions, have the potential of significantly affecting the magnitude of private firm costs. At the time of the writing of this guidebook, however, the cost impacts of these programs are unclear.

The ICR program, which is designed to recover from connected industries some of the capital costs associated with publicly owned treatment works (POTWs) expansion, has been suspended by EPA. It may with further Congressional review be reinstituted at a later date.

Three of the main purposes of ICR were as follows:

- require industries to pay their fair share of public treatment facility capital costs;
- reduce inequities between industries that must self-treat and discharge directly to streams and those industries tied into publicly owned treatment works (POTWs);
- minimize unnecessary overcapacity in POTWs anxious to attract industry.

In any case, because of the uncertainty associated with the ICR program, ICR impacts are not considered in this guidebook. An example of typical ICR cost apportionment is shown, however, in Example 8-1.

EPA's pretreatment regulations under Section 307 of PL92-500, on the other hand, are still incomplete. EPA is still developing final effluent limitations. In setting future pretreatment standards, EPA is focusing on 21 industry categories believed to be discharging pollutants of the greatest concern. These industries are as follows:

- Electroplating
- Leather Tanning & Finishing
- Petroleum Refining
- Textile Mills
- Automatic & other Laundries
- Iron & Steel Manufacturing
- Ore Mining
- Inorganic Chemicals Manufacturing
- Nonferrous Metals Manufacturing
- Steam Electric Power Plants
- Timber Products Processing
- Coal Mining
- Machinery & Mechanical Products Manufacturing
- Organic Chemicals Manufacturing

8-1

Example 8-7

CALCULATION OF ANNUAL AND TOTAL ICR PAYMENT REQUIREMENTS FOR LOST RIVER SANITARY DISTRICT

(1.9 MGD New Secondary Plant; 1977 Start Up)

USER	Design Daily Flow and Loadings	$17.636 1,000 G/D/Year Flow	$2.505 Lbs./D/Year BOD	$0.854 Lbs./D/Year S.S.	TOTAL
A. Significant (10%+) Sometime Oil	200,000 g flow 1,200 lbs. BOD 1,000 lbs. S.S.	$3,527.20	$3,006.00	$854.00	$ 7,387.20
B. Major (5-10%) Average Ice Cream	150,000 g flow 600 lbs. BOD 1,000 lbs. S.S.	2,645.40	1,503.00	854.00	$ 5,002.40
C. Minor (1-5%) Bouncy Baby Shoe	70,000 g flow 350 lbs. BOD 590 lbs. S.S.	1,234.52	876.75	503.86	$ 2,615.13
D. Minor Group (-1%) Daily Egg Hot Fireclay Reliable Gas Long Wire } Design Average per User	3,750 g flow 30 lbs. BOD 45 lbs. S.S.	66.13	75.15	38.43 4 X $179.71 =	$ 718.84
E. Dry-Sanitary Only[1] Accountable Data, Inc.	15,000 g flow 30 lbs. BOD 30 lbs. S.S.	264.54	75.15	25.62	$ 365.31
Total ICR Per Year Payable for the First Year[2]					$ 16,088.88
Total ICR (1977-2007): at a constant rate would be 30 years X $16,088.88 =					$482,666.40

[1] Grantee has chosen not to exempt sanitary wastes.

[2] ICR is to be reevaluated and updated each year based upon monitoring of industrial users.

Source: Environmental Protection Agency, "Industrial Cost Recovery Systems", MCD-44, November, 1976.

- Paint & Ink Formulation & Printing
- Paving & Roofing Materials
- Plastic & Synthetic Materials Manufacturing
- Pulp & Paperboard Mills & Converted Paper Products
- Rubber Processing
- Soap & Detergent Manufacturing

For many areawide planning agencies, it will be difficult to assess cost impacts until these regulations are published in final form.

The Effect of Private Firm Financing Methods

Ideally impact assessment in areawide planning would be able to show the effects on industries of self-treatment versus connection to a POTW. This is probably impractical within areawide water quality planning for at least two reasons: 1) the difficulty in getting financial data from affected firms; 2) the wide variety of financing mechanisms available to firms that can alter the financial impact of water quality control alternatives. These financing mechanisms include:

- rapid amortization of pollution control facilities;
- investment tax credits;
- industrial development bonds;
- SBA loans; and
- centralized purchasing.

In general, in cases where water quality controls will entail capital investment on the part of firms, it will be very difficult for the water quality planner to assess actual annual costs because of the individual firm financing decisions.

Individual Firm Physical Responses

An additional uncertainty in estimating actual financial impact of water quality controls on industrial and commercial firms involves internal plant changes in response to controls. Faced with increased pollution abatement costs, a firm, where possible, may attempt to reduce pollution abatement-related costs through a variety of practices. As suggested in Section 8.1, faced with sewer and surcharges, a firm can select one or more of the following responses:

- pay the fee
- pretreat wastes prior to discharge to POTW

- improve housekeeping procedures
- change process technology
- change products manufactured
- reduce output, possibly to zero and go out of business
- self-treat wastes prior to direct discharge

In a study of 101 industries and their response to sewer surcharge in Atlanta, South San Francisco, Chicago, Salem (Oregon), and Dallas, it was found that the four most typical responses were those shown in Exhibit 8-3. While not all these responses were effective in significantly reducing the financial effect of sewer charges, the study of these firms found that many responses were effective in reducing costs.

Screening Analysis

Industrial and Commercial Firms--

The screening step in this impact category should focus on the following activities:

- determine and categorize water quality control strategies proposed for industries and firms;
- determine approximate number and type of firms affected;
- determine type of information sources available about industries and their waste characteristics.

Each of these activities is briefly discussed below.

The first activity should summarize, probably by community, the types of alternative strategies proposed for industries and firms. The point of this activity is to note the potential cumulative aspect of water quality controls on industries and firms. It is probably most convenient to classify strategies along the following lines:

For POTW-Connected Industries

- local sewer use charges or surcharges;
- local water use charges;
- Federal or locally-motivated pretreatment requirements;
- local water conservation requirements.

Exhibit 8-3

TYPICAL[1] RESPONSE OF INDUSTRIES TO LOCAL SEWER CHARGES AND SURCHARGES (ATLANTA, SOUTH SAN FRANCISCO, CHICAGO, SALEM (OR), DALLAS)

	# Plants	Comments
Water Conservation	38	Strong drought response in Salem and South San Francisco
Improved Housekeeping	53	Most common response to charges
Installed or Augmented Treatment	44	In many of these cases, regulations were the main reason for installing pretreatment
Altered Production	41	Includes changing products, inputs, process flow, or equipment

[1] Multiple responses possible.

Source: Urban Systems Research and Engineering, Inc., "Responses to Local Sewer Charges and Surcharges," prepared for Council on Environmental Quality, October 1979.

For Direct Discharging Industries

- NPDES-mandated self-treatment requirements

The second and third activities will probably be best accomplished if done simultaneously. In order to do this, it will be necessary to determine the major secondary data sources containing information about local industry. The following sources are the types of data sources that should be gathered and examined in this screening activity, if they are available:

- NPDES Discharge Permits;
- industrial waste directories;
- POTW facility plans;
- industrial directories.

In addition, POTW administrators should be contacted to determine the type and availability of records that show the names of firms connected to the POTW. In some communities, sewer charges may be based on water use and in these cases the water departments will have to be contacted.

At the completion of these screening activities, the water quality planner should be able to identify types of controls and be able to match, at a minimum, the number of firms affected by each strategy. In some cases, specific affected firms can be grouped for each control strategy, as shown in Example 8-2. In this example, Federal pretreatment target industries are identified by SIC code and the state industrial directory is used to determine affected firms in Union City.

The key decisions to make at this point revolve around the following issues:

- Which industries should be looked at in more detail for impacts?
- Should impacts be looked at on a firm-by-firm basis?

In addressing these issues, it should be kept in mind the importance of this impact category to the Employment and Economic Growth impact category. The Private Firm Cost impact category should serve to identify those firms that are most vulnerable to employment losses or plant closure due to pollution abatement costs. Thus, at a minimum, the analysis at this point should proceed to examine in more detail those plants that are most vulnerable to added pollution abatement costs. Given the probable lack of actual financial information on a plant-by-plant basis at this point, the water quality planner should attempt to determine the following categories of firms:

8-2

Example 8-2

UNION CITY FIRMS AFFECTED BY PROPOSED PRETREATMENT REQUIREMENTS

Major Product Category	Firm Name
Electroplaters	Advanced Plating
	A.A. Brunel
	Eagle Electroplating
	Edward P. Garrepy
	Hard Chrome Division
	Independent Electroplating
	Metal-Kote
	New Method Plating
	Qualatron Electroplating
	Reliable Plating
Miscellaneous Machine Tools, Parts, and Metal Parts	Anderson Corp.
	Anderson Tool & Stamping
	John Bath Co.
	Cincinnati Milacron
	Coes Knife
	Crompton & Knowles
	G&R Screw Machine
	Henry L. Hanson
	Jamesbury Corp.
	Lundquist Tool Mfg.
	Morgan Construction
	Parker Mfg.
	Parker Metal Goods
	Reed & Prince Co.
	Thomas Smith Co.
	Warner & Swasey
Other Metal Products	Lindberg Corp.
	Mass Steel Treating
	Mercury Wire
	National Standards
	Standard Foundry
	Thompson Steel
	Worcester Pressed Aluminum
	G.F. Wright Co.
	Wyman and Gordon
Plastics	Dacor Corp.
	Holden Plastics
	Produx Co.
	Worcester Moulded Plastics
Leather	L. Farber
	E.W. Parks
Textiles	O.K. Wool Co.
	Robinson Thread
	Eli Sandman
Food	Laipson's Dairy
	Millbrook Co.
	Pepsi-Cola
	Polar Corp.
	Table Talk Pies

Category 1: Those industries or firms that will potentially bear the greatest costs

Category 2: Those industries or firms that are recognized as being the least able to pass along increased pollution abatement costs

Category 3: Those firms that fall into both category 1 and 2.

Category 1 firms may include firms with high strength wastes, such as wastes with high Biochemical Oxygen Demand (BOD); firms with special or exotic wastes requiring sophisticated treatment technology; firms that are large water users. Category 2 firms can be identified locally through the Chamber of Commerce or Economic Development Agencies. Vulnerability factors cited in Section 8.1 will be useful in making these determinations. The National Commission on Water Quality (NCWQ) has also idenfified seven (7) industries as being particularly susceptible to pollution abatement costs: chemical, electric utilities, iron and steel, paper, mining, petroleum, and machinery and mechanical products (including metal finishing and fabrication). Finally, the regional EPA office may be source of information on vulnerable firms. EPA has set up in conjunction with the Department of Labor an economic dislocation early warning system which monitors plant closings where federal, state, or local pollution control regulations were a substantial factor in the closings.

The extent to which the water quality planning agency will want to proceed with more detailed analysis will depend in large part on available staff resources and desires of the agency's advisory committee. For example, certain communities may be targeted for special attention or firms over a certain employment size.

Agricultural Producers--

The screening step for agriculture should attempt to provide information similar to that for industrial and commercial firms, namely:

- determine and categorize water quality strategies proposed for farms;
- determine approximate number and type of farms affected;
- determine type of information sources available about farms and their types of water quality issues.

The ability to match information for the first and second activities will depend on how site-specific the water quality planning agency was in looking at non-point source agricultural problems prior to recommending best management practices. Based on data generated during the water quality planning process, the screening analysis will hopefully be able to identify problem watershed areas with specific types of non-point source problems.

134

If site-specific information about farms was not generated during the water quality planning process, the planner should use the problem watershed information and determine from the local Cooperative Extension Service or the County Soil Conservation Service the type of agricultural operations in each of these watersheds. The planner should also consult with the State water pollution control agency to determine those farms affected by NPDES permits. These permits may apply to irrigation return flow situations and to farms with livestock waste.

Similar to the industrial screening process, the planner has several options at this point as to how to proceed. Specific agricultural operations, categorized by crop type or those with large scale livestock waste disposal problems for example, may be singled out for further analysis.

8.4 MEASUREMENT TECHNIQUES

Industrial and Commercial Firms

Capital Costs--

Some firms discharging directly to streams as well as those connected to POTWs will face some type of capital investment in response to NPDES requirements and pretreatment requirements. Those firms connected to POTWs that desire to reduce the cost burden of sewer user charges and surcharges may also respond with some type of capital investment.

As indicated in the screening analysis, obtaining capital cost information may be difficult. Unless it has been generated in the areawide quality study, the planner will then have only two options for estimating capital cost information. First, if there are not a great number of firms for which this information is needed, it may be possible to obtain this information directly from the firm. They may have had an engineering firm develop order of magnitude cost estimates. The second option is to develop these costs in a crude fashion using information about the firm's wastes and estimating costs from engineering cost curves developed by EPA for selected industries. See the Development Planning and Research Associates, Inc. reference, for example. It should be noted of course, that this technique will only produce crude estimates.

If capital cost information has been developed, then it may be used to develop the indicators shown in Examples 8-3 and 8-4. For Example 8-4, the capital cost component of wastewater treatment facilities will most likely be financed over a moderate term -- 3 to 5 years. It should be clear, however, that since the useful life of the pollution abatement equipment purchased by each firm is generally greater than 5 years, total annual costs will decrease after completion of the 3 to 5 years payback period to an amount equal to O&M costs alone.

If gross sales and assessed valuation of capital stock information for a firm is available, then ratios may be developed to show compliance

8-3

Example 8-3

TREATMENT COST ESTIMATES

	Preferred Alternative			
Firm	Flow (GPD)	Total Capital Cost	Annual O&M Cost	Discharge to:
Advanced Plating	6,000	$62,200	$ 5,350	sanitary sewer
Anderson Corp	4,000	8,000	3,450	sanitary sewer
Anderson Tool & Stamping	600	3,000	2,050	sanitary sewer
Astra Pharmaceutical	88,000	7,200	5,600	sanitary sewer
John Bath Co.	(small amount)	3,000	2,000	sanitary sewer
A.A. Brunel	6,000	23,500	4,900	sanitary sewer
Cincinnati Milacron	238,000	20,800	13,700	sanitary sewer
Coes Knife	5,000	9,500	3,550	sanitary sewer
Crompton & Knowles	6,600	11,300	3,950	sanitary sewer
Dacor Mfg.	2,000	5,000	1,250	sanitary sewer
Eagle Electroplating	50,000	58,000	11,650	sanitary sewer
L. Farber Co.	21,000	25,300	5,800	sanitary sewer
G&R Screw Machine	2,000	3,000	2,250	sanitary sewer
Edw. F. Garrepy	10,000	75,300	7,900	sanitary sewer
Henry L. Hanson	1,000	3,000	2,130	sanitary sewer
Hard Chrome Division	25,000	73,500	11,750	sanitary sewer
Hobbs Mfg.	1,500	3,000	2,200	sanitary sewer
Holden Plastics	7,000	6,300	2,700	storm drain
Independent Electroplating	50,000	93,000	16,850	sanitary sewer
Jamesbury Corp.	75,000	71,700	20,950	sanitary sewer
Laipson's Dairy	15,000	—	2,200	sanitary sewer
Lindberg Corp.	800	3,000	2,150	sanitary sewer
Lundquist Tool & Mfg.	100	3,000	2,000	sanitary sewer
Mass Steel Treating	26,000	51,600	14,750	sanitary sewer
Mercury Wire	3,000	—	1,000	sanitary sewer
Metal-Kote	3,000	3,000	2,900	sanitary sewer
Millbrook, Inc.	105,000	2,100	15,950	sanitary sewer
Morgan Construction	11,000	17,300	5,350	sanitary sewer
National Standards	30,000	48,800	9,650	sanitary sewer
New Method Plating	15,000	84,500	10,500	sanitary sewer
Norton Co.	1,050,000	204,100	207,450	sanitary sewer
O.K. Wools	10,000	23,700	2,550	sanitary sewer
Parker Mfg.	37,000	51,500	17,650	sanitary sewer
Parker Metal Goods	50,000	60,800	18,350	sanitary sewer
E.W. Parks	300	—	—	sanitary sewer
Pepsi-Cola	10,000	22,300	1,650	sanitary sewer
Polar Corp	100,000	52,800	25,300	sanitary sewer
Produx Co.	17,000	15,000	4,600	stream
Qualatron Electroplating	72,000	18,000	12,350	sanitary sewer
Reed & Prince Mfg.	106,000	36,500	23,650	sanitary sewer
Reliable Plating	6,500	40,000	3,250	sanitary sewer
Robinson Thread	3,000	25,300	9,800	sanitary sewer
Eli Sandman Co.	10,000	10,000	3,950	sanitary sewer
Thomas Smith Co.	10,000	16,300	5,000	sanitary sewer
Sprague Electric	90,000	102,500	27,500	sanitary sewer
Standard Foundry	9,000	64,000	8,350	sanitary sewer
Table Talk	9,000	8,000	3,100	stream
Thompson Wire	53,000	102,800	25,050	sanitary sewer
Warner & Swasey	not available	8,800	3,250	stream
Worcester Moulded Plastics	15,000	26,800	5,700	sanitary sewer
Worcester Pressed Aluminum	1,000	3,000	2,150	sanitary sewer
G.F. Wright	105,000	—	15,350	sanitary sewer
Wright Line	not available	33,000	7,650	sanitary sewer
Wyman Gordon	10,000	9,300	57,000	sanitary sewer

NOTE: 1. Flow estimates exlude cooling water recycling in most cases.

2. Discharge to sanitary sewers indicates pretreatment option.

3. Discharge to storm drains or stream indicates self-treatment option.

8-4

Example 8-4

ANNUAL POLLUTION ABATEMENT COSTS

Firm	Finance Period = 3 years Annual Capital Cost	Annual O&M Cost	Total Annual Cost	Finance Period = 5 years Annual Capital Cost	Annual O&M Cost	Total Annual Cost
Advanced Plating	25,680	5,350	31,030	17,040	5,350	22,390
Anderson Corp.	3,300	3,450	6,750	2,190	3,450	5,640
Anderson Tool & Stamping	1,240	2,050	3,290	820	2,050	2,870
Astra Pharmaceutical	2,970	5,600	8,570	1,970	5,600	7,570
John Bath Co.	1,240	2,000	3,240	820	2,000	2,820
A.A. Brunel	9,700	4,900	14,600	6,440	4,900	11,340
Cincinnati Milacron	8,590	13,700	22,290	5,700	13,700	19,400
Coes Knife	3,920	3,550	7,470	2,600	3,550	6,150
Crompton & Knowles	4,660	3,950	8,610	3,100	3,950	7,050
Dacor Mfg.	2,060	1,250	3,310	1,370	1,250	2,620
Eagle Electroplating	23,940	11,650	35,590	15,890	11,650	27,540
L. Farber Co.	10,440	5,800	16,240	6,930	5,800	12,730
G&R Screw Machine	1,240	2,250	3,490	820	2,250	3,070
Edw. P. Garrepy	31,080	7,900	38,980	20,630	7,900	28,530
Henry L. Hanson	1,240	2,150	3,390	820	2,150	2,970
Hard Chrome Division	30,340	11,750	42,090	20,140	11,750	31,890
Hobbs Mfg.	1,240	2,200	3,440	820	2,200	3,020
Holden Plastics	2,600	2,700	5,300	1,730	2,700	4,430
Independent Electroplating	38,390	16,850	55,240	25,480	16,850	42,330
Jamesbury Corp.	29,600	20,950	50,550	19,640	20,950	40,590
Laipson's Dairy	—	2,200	2,200	—	2,200	2,200
Lindberg Corp.	1,240	2,150	3,390	820	2,150	2,970
Lundquist Tool & Mfg.	1,240	2,000	3,240	820	2,000	2,820
Mass Steel Treating	21,300	14,750	36,050	14,140	14,750	28,890
Mercury Wire	—	1,000	1,000	—	1,000	1,000
Metal-Kote	1,240	2,900	4,140	820	2,900	3,720
Millbrook, Inc.	870	15,950	16,820	580	15,950	16,530
Morgan Construction	7,140	5,350	12,490	4,740	5,350	10,090
National Standards	20,140	9,650	29,790	13,370	9,650	23,020
New Method Plating	34,880	10,500	45,380	23,150	10,500	33,650
Norton Co.	84,250	207,450	291,700	55,900	207,450	263,370
O.K. Wools	9,780	2,550	12,330	6,490	2,550	9,040
Parker Mfg.	21,260	17,650	38,910	14,110	17,650	31,760
Parker Metal Goods	25,100	18,350	43,450	16,660	18,350	35,010
E.W. Parks	—	—	—	—	—	—
Pepsi-Cola	9,200	1,650	10,850	6,110	1,650	7,760
Polar Corp.	21,790	25,300	47,090	14,470	25,300	39,770
Produx Co.	6,190	4,600	10,790	4,110	4,600	8,710
Qualatron Electroplating	7,430	12,350	19,780	4,930	12,350	17,280
Reed & Prince Mfg.	15,070	23,650	38,720	10,000	23,650	33,650
Reliable Plating	16,510	3,250	19,760	10,960	3,250	14,210
Robinson Thread	10,440	9,800	20,240	6,930	9,800	16,730
Eli Sandman Co.	4,130	3,950	8,080	2,740	3,950	6,690
Thomas Smith Co.	6,810	5,000	11,810	4,520	5,000	9,520
Sprague Electric	42,310	27,500	69,810	28.080	27,500	55,580
Standard Foundry	26,420	8,350	34,770	17,530	8,350	25,880
Table Talk	3,300	3,100	6,400	2,190	3,100	5,290
Thompson Wire	42,430	25,050	67,480	28,170	25,050	53,220
Warner & Swasey	3,630	3,250	6,880	2,410	3,250	5,660
Worcester Moulded Plastics	11,060	5,700	16,760	7,340	5,700	13,040
Worcester Pressed Aluminum	1,240	2,150	3,390	820	2,150	2,970
G.F. Wright	—	15,350	15,350	—	15,350	15,350
Wright Line	13,620	7,650	21,270	9,040	7,650	16,690
Wyman Gordon	3,840	57,000	60,840	2,550	57,000	59,550

NOTE: All costs rounded to nearest $10.

burden. City property assessments may be used to estimate capital stock in-place, but their assessments often exclude leased capital stock and may exclude other types of capital equipment. As seen in Examples 8-5 and 8-6, the effects appear to be greatest on electroplaters and plastic products manufacturers.

User Charges and Surcharges--

If flow information is available for a firm then the amount of sewer and water user charges can be directly estimated. Those costs are included in the annual O&M costs of Example 8-4. If the user charge system and the surcharge system also charge for waste strength, then the waste characteristics will also be necessary to know the "charge formula" to estimate these costs. See Example 8-7.

Property Taxes--

To the extent that the planner has been able to estimate other water quality costs for a community that will be reflected in property taxes, then these taxes represent a water quality-related cost burden for firms and can be calculated on a case-by-case basis.

Agricultural Producers

If there is not specific information available on capital costs of proposed water quality controls for farmers, then the planner will have to rely on the Soil Conservation Service or the Cooperative Extension Service to develop average acre costs. These can be then applied to specific farms or to the entire agricultural acreage affected in a watershed to develop amount of compliance costs. The ability to express this data as a percentage of production costs or income will probably be limited by the lack of specific information on farms. The 1979 U.S. Census of agriculture does provide acreage, production costs, and income figures, however, at the County level. Per acre production costs and income figures can be derived for specific types of farms and this information used with per acreage water quality costs to reflect compliance burden. See Example 8-8. The Cooperative Extension Service or the State Agriculture Department may also be able to provide current income and production costs for various types of agricultural operations.

8.5 DATA REQUIREMENTS

Data requirements and sources for this impact category are presented in Exhibits 8-4 and 8-5.

8-5

Example 8-5

POLLUTION ABATEMENT INVESTMENT AS A PERCENTAGE OF FAIR MARKET VALUE OF CAPITAL STOCK

		Capital Stock		
Industry Type	Firm Name	Assessed Value	Fair Market Value	Required Water Pollution Abatement Investment as a % Fair Market Value of Existing Capital Stock
Electroplating	Advanced Plating	N.A.	—	—
	A.A. Brunel	17,000	45,900	51.20
	Eagle Electroplating	N.A.	—	—
	Edw. P. Garrepy	55,000	148,600	50.67
	Hard Chrome Division	N.A.	—	—
	Independent Electroplating	N.A.	—	—
	Metal-Kote	193,000	521,600	0.58
	New Method Plating	70,700	191,100	44.22
	Qualatron Electroplating	N.A.	—	—
	Reliable Plating	30,700	83,000	48.19
Miscellaneous Machine Tools and Parts, Metal Parts	Anderson Corp.	240,100	648,900	1.23
	Anderson Tool & Stamping	N.A.	—	—
	John Bath Co.	98,400	265,900	1.13
	Cincinnati Milacron	1,071,600	2,896,200	0.72
	Coes Knife	165,000	445,900	2.13
	Crompton & Knowles	298,000	805,400	1.40
	G&R Screw Machine	N.A.	—	—
	Henry L. Hanson	545,000	1,473,000	0.20
	Jamesbury Corp.		3,500,000	2.05
	Lundquist Tool Mfg	N.A.	—	—
	Morgan Construction Co.	1,663,200	4,495,100	0.38
	Parker Mfg.	271,900	734,900	7.01
	Parker Metal Goods	N.A.	—	—
	Reed & Prince	595,600	1,609,700	2.27
	Thomas Smith Co.	143,200	387,000	4.26
	Warner and Swasey	1,620,000	4,378,400	0.20
Other Metal Products	Lindberg Co.	138,200	373,500	0.80
	Mass Steel Treating	310,500	839,200	6.15
	Mercury Wire	N.A.	—	—
	National Standards	494,800	1,337,300	3.65
	Standard Foundry	416,400	1,125,400	3.69
	Thompson Steel	277,000	748,600	13.73
	Worcester Pressed Aluminum	206,700	558,600	0.54
	G.F. Wright Co.	370,700	1,001,900	0.00
	Wyman Gordon	1,869,300	5,052,200	0.18
Plastics	Dacor Corp.	31,000	83,800	5.97
	Holden Plastics	18,400	49,700	12.68
	Produx Co.	N.A.	—	—
	Worcester Moulded Plastics	195,800	529,200	5.06
Leather	L. Farber	167,000	451,400	5.60
	E.W. Parks	N.A.	—	—
Textiles	O.K. Wool Co.	N.A.	—	—
	Robinson Thread	83,000	224,300	11.28
	Eli Sandman Co.	102,500	277,000	3.61
Food	Laipson's Dairy	16,100	43,500	0.00
	Milbrook Co.	801,000	2,164,900	0.10
	Pepsi Cola	N.A.	—	—
	Polar Corp.	352,400	952,400	5.54
	Table Talk Pies	601,200	1,624,900	0.55
Miscellaneous	Astra Pharmacutical	1,479,500	3,998,600	0.18
	Bobbs Mfg.	N.A.	—	—
	Norton Co.	12,137,300	32,803,500	0.62
	Sprague Electric	520,000	1,405,400	7.29
	Wright Line	857,000	2,316,200	1.42
	MEDIAN VALUE			2.13

Example 8-6

ANNUAL COSTS AS A PERCENTAGE OF GROSS ANNUAL SALES FOR FIRMS BY INDUSTRY TYPE

Industry Type	Firm Name	Annual Costs, Percent of Gross Sales*	
		3-year Capital Financing	5-year Capital Financing
Electroplating	Advanced Plating	—	—
	A.A. Brunel	—	—
	Eagle Electroplating	7.12	5.51
	Edw. P. Garrepy	—	—
	Hard Chrome Division	7.02	5.32
	Independent Electroplating	—	—
	Metal-Kote	—	—
	New Method Plating	7.26	5.38
	Qualatron Electroplating	6.59	5.76
	Reliable Plating	10.98	7.89
Miscellaneous Machine Tools & Parts, Metal Parts	Anderson Corp.	—	—
	Anderson Tool & Stamping	—	—
	John Bath Co.	0.16	0.14
	Cincinnati Milacron	—	—
	Coes Knife	—	—
	Crompton & Knowles	—	—
	G&R Screw Machine	—	—
	Henry L. Hanson	0.02	0.01
	Jamesbury Corp.	0.08	0.07
	Lundquist Tool Mfg.	0.16	0.14
	Morgan Construction Co.	—	—
	Parker Mfg.	0.43	0.35
	Parker Metal Goods	—	—
	Reed and Prince	0.18	0.15
	Thomas Smith Co.	0.39	0.32
	Warner & Swasey	0.04	0.03
Other Metal Products	Lindberg Co.	—	—
	Mass Steel Treating	0.34	0.28
	Mercury Wire	—	—
	National Standards	—	—
	Standard Foundry	—	—
	Thompson Steel	—	—
	Worcester Pressed Aluminum	0.11	0.10
	G.F. Wright Co.	—	—
	Wyman Gordon	0.02	0.02
Plastics	Dacor Corp.	—	—
	Holden Plastics	0.66	0.55
	Produx Co.	1.08	0.87
	Worcester Moulded Plastics	0.56	0.43
Leather	L. Farber Co.	—	—
	E.W. Parks	0.00	0.00
Textiles	O.K. Wool Co.	0.43	0.32
	Robinson Thread	0.34	0.28
	Eli Sandman Co.	0.23	0.19
Food	Laipson's Dairy	0.05	0.05
	Millbrook Co.	—	—
	Pepsi-Cola	—	—
	Polar Corp.	0.47	0.40
	Table Talk Pies	—	—
Miscellaneous	Astra Pharmaceutical	—	—
	Hobbs Mfg.	—	—
	Norton Co.	—	—
	Sprague Electric	0.54	0.43
	Wright Line	0.10	0.08
	MEDIAN VALUE	0.34	0.28

* *During finance period only. This percentage would decrease after the end of a 3 or 5 year period.*

8-7

Example 8-7

TYPICAL SEWER SURCHARGE FORMULA

$$\$/ccf = V + A\ (C - C_o)\ TSS\ A\ (B - B_o)\ BOD$$

where: V = volume related charge ($/ccf)

TSS = Total Suspended Solids related charge ($/pound)

BOD = Biochemical Oxygen Demand related charge ($/pound)

C = actual TSS concentration (mg/1)

C_o = "normal" TSS concentration (mg/1)**

B = actual BOD concentration (mg/1)

B_o = "normal" BOD concentration (mg/1)**

A = conversion factor from mg/1 to lb/ccf = .006238

In Atlanta, the formula is:

$$\$/ccf = \$.88 + \$.105 \ X\ .006238\ X\ (C - 250) + (B - 250)$$

Example 8-8

AGRICULTURAL COST BURDEN, EXETER COUNTY

1974 Total Farm Income for Corn in Exeter County = $75,000,000

Converted to 1979 prices = $123,000,000

1974 Acres in Corn = 15,000 acres

Average 1979 Income/Acre = $8200

Average erosion control costs/acre for South River Watershed in Exeter County = $175

Average erosion control costs/acre for Lost River Watershed in Exeter County = $400

South River Watershed costs/income = .02

Lost River Watershed costs/income = .05

Exhibit 8-4

INDUSTRIAL & COMMERCIAL FIRM COSTS DATA SOURCES

Data Item	Data Source	Use
--EPA pretreatment requirements;	● EPA	Screening analyis
--NPDES requirements	● State Water Pollution Control Agency	
--Local pretreatment requirements	● Local POTW	Screening Analysis
--Affected firms	● Local POTW ● Industrial directories ● NPDES	Screening Analysis
--Water quality compliance costs		
o Capital	● Affected firm ● EPA development documents	Screening & Measurement Analyses
o User charges and surcharges	● Local POTW	
--Waste volume and characteristics	● Affected firm ● Local POTW (Industrial Waste Survey)	Measurement Analysis
--Gross annual sales	● Affected firm	Measurement Analysis
--Capital stock value	● Affected firm	Measurement Analysis
--Tax increases associated with other water quality costs	● Chapter 7	Measurement Analysis
--Tax structure	● Local tax assessor	Measurement Analysis

Exhibit 8-5

AGRICULTURAL FIRM COSTS DATA SOURCES

Data Item	Data Source	Use
--NPDES requirements	● EPA ● State Water Pollution Control Agency	Screening Analysis
--Water quality compliance costs	● 208 Study ● SCS/Cooperative Extension Service	Screening and Measurement Analyses
--Affected farms	● NPDES ● 208 Study ● SCS/Cooperative Extension Service	Screening
--Income and Production	● SCS/Cooperative Ex- ● tension Service ● 1979 U.S. Census of Agriculture	Measurement Analysis
--Acreage	● Same as above	Measurement Analysis

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*See also U.S. Environmental Protection Agency Development Documents for other industries. Regional EPA offices will have current listings of all such documents.

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CHAPTER 9

Employment and Economic Growth

9.1 IMPACT DESCRIPTION

Impact Definition

One of the key impact concerns of water quality strategies, particularly industrial effluent restrictions and sewer use charges, is the effect on local and regional businesses. The number of firms and employment are basic indicators of business activity. Employment is defined as the number of people working--both full-time and part-time--in an area.

The focus of this impact category is at the regional and sub-regional level. Water quality controls will often have effects in a particular industry throughout the country because of uniform effluent limitations. This impact category is limited to those localized effects that are calculable by the local planning agency.

Impact Issues

A water pollution control strategy can influence business activity in an area by increasing or decreasing the levels of employment, value added and/or income. There are three types of business activity changes associated with water pollution control strategies:

- Direct impacts
- Indirect impacts
- Accelerator impacts

Direct Impacts--

Water pollution control strategies may affect economic growth directly through the purchases of land, labor and materials for the construction of facilities. Some or all of the money for the resulting materials, labor and land purchases may be injected into the economy, although the impact assessment should be careful to note the temporary nature of construction-related employment. Locally-raised funds merely reallocate indigenous resources and, thus, do not usually have as significant per dollar economic impacts as exogenous funds, which represent additional inputs into the local economy.

The implementation of a water quality strategy directly affects permanent employment. There will be an increase in personnel to operate and maintain facilities and to administer and manage various institutional arrangements associated with water quality strategies.

Indirect Impacts--

The demand for labor, land, or materials related to a strategy will create new demand for other goods as well. For example, the construction workers will demand goods and services with their pay from the project. In turn, the firms that receive the construction workers' pay will respend this money, resulting in more demand. This indirect increase in demand is called the multiplier effect. Thus, a dollar spent on a water pollution control strategy may add, for example, two dollars to the total real local product before that money passes out of the local economic system.

The impact of the multiplier effect varies with local circumstances. During the construction phase, it is particularly sensitive to the purchasing patterns of workers. The size of the multiplier differs between construction workers and those that operate and maintain the facility. Construction workers are hired for relatively short periods of time and are sometimes not local. Thus, a portion of their income goes home with them. If construction and maintenance materials are bought from local suppliers, then the multiplier is further increased. The process of spending and respending continues until the money leaves the local economy through "leakages" to other regions or areas (or products or services not purchased locally).

Through the multiplier discussed above, implementation of a strategy may also indirectly increase employment. As a project demands more materials for construction, for example, the firm supplying those materials must hire more employees to manufacture and distribute its product. This, in turn, may generate more employment in the retail and service sectors in order to fulfill the retail and service needs of this personnel. Also, increased construction employment may generate increased service and retail employment directly. The amount of indirect employment generated varies with the multiplier. That is, it is subject to the same factors and influences described above.

The multipler effect can also be calculated on employment resulting from accelerator effects (discussed below) and employment needed to operate facilities. The multiplier effects associated with these employment changes are more permanent than the effects associated with construction of wastewater facilties. Thus, if you calculate multiplier effects, you should probably concentrate on the permanent multiplier effects.

Accelerator Effects--

Accelerator growth is defined as the economic growth which occurs in an area as a result of the movement of firms into, or our of the area in response to a change in the relative attributes of the area. These attributes may be cost-related (i.e., increasing or decreasing the relative cost of production associated with an area) or non-cost related (e.g., altering the perceived relative amenity qualities of an area). Accelerator growth may be either positive or negative.

The implementation of a water quality management program may encourage a firm to move to or out of a new region in six ways:

- by changing total amount of wastewater treatment capacity available locally;
- by changing the availability of special waste handling facilities;
- by changing the local geographic availability of centralized wastewater treatment services;
- by changing the local per unit wastewater treatment costs;
- by changing the aesthetic attractiveness of an area (i.e., changes in amenity qualities); and
- by sewering a previously undeveloped piece of land.

Any of these factors may affect an area's attractiveness to industry in a positive or negative manner. For example, firms might be attracted to an area where particularly low treatment costs prevail. Alternatively, the imposition of stringent pretreatment requirements might be a factor for certain industries to go out of business; to cut back production; to move to a location that had a centralized system more compatible with their wastewater characteristics or to a location where specialized wastewater treatment facilities exist. Finally, the availability of sewers in a suburban location, where land costs were relatively low, might induce central city firms to relocate. Thus, the precise form of a wastewater program may induce inter- and intra-regional firm movement and may have positive or negative regional and/or local employment impacts. However, the influence of wastewater treatment availability and costs and amenity factors are very seldom an overriding factor in the locational decisions of any firms. Rather they must be considered as one of many elements in any firm's

149

locational decision, with such factors as transportation costs and labor availability assuming greater importance. Exhibit 9-1 summarizes these impact relationships.

9.2 IMPACT INDICATORS

The types of impact indicators of most interest and capable of being estimated within the limits of an areawide water quality for facility planning impact assessment are the following:

- changes in employment, e.g.,
  --public service employment
  --construction employment
  --manufacturing employment
  --services employment
  --etc.
- changes in total employment, unemployment rate
- changes in number of firms, e.g.
  --new firms by type
  --loss of firms by type

Changes in employment associated with the implementation of water quality strategies is the most appropriate indicator in this impact category. Of particular interest are the following types of employment changes:

- construction employment associated with the development of a structural water quality control;
- public service employment associated with operating, regulating, and administering water quality controls;
- public service employment associated with changes in public service demand effects of water quality controls;
- construction employment associated with indirect development effects of water quality controls.

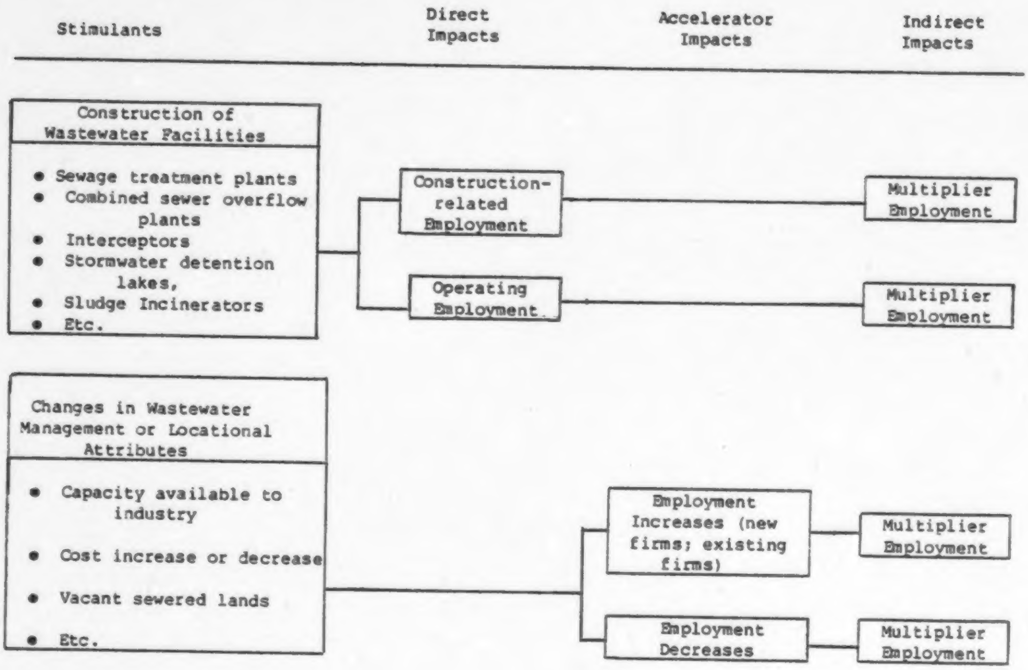
Because of all the influences on local employment, it will probably be impractical for the water quality planner to determine the impact of employment effects associated with water quality strategies on the unemployment rate. Changes in the number of firms, particularly industrial ones is important for determing manufacturing employment changes and related tax base changes for the Public Fiscal Impact category.

It is particularly important in estimating employment impacts to provide a time dimension where possible. For instance, it may sound significant that a sewer will stimulate 1000 new manufacturing jobs. But if these are

150

Exhibit 9-1

EMPLOYMENT IMPACTS ASSOCIATED WITH WATER QUALITY STRATEGIES


Stimulants
Direct Impacts
Accelerator Impacts
Indirect Impacts
Construction of Wastewater Facilities
• Sewage treatment plants
• Combined sewer overflow plants
• Interceptors
• Stormwater detention lakes,
• Sludge Incinerators
• Etc.
Construction-related Employment
Multiplier Employment
Operating Employment
Multiplier Employment
Changes in Wastewater Management or Locational Attributes
• Capacity available to industry
• Cost increase or decrease
• Vacant sewered lands
• Etc.
Employment Increases (new firms; existing firms)
Multiplier Employment
Employment Decreases
Multiplier Employment

spread out over 15-20 years, the impact is not quite as dramatic.

An additional feature in expressing employment changes is to show changes as a percentage of existing employment sectors: for example, "construction employment associated with the construction of the new sewerage project represents 20% of total construction employment in the region."

9.3 PRELIMINARY CONSIDERATIONS

The most important preliminary consideration in this impact category is close coordination with other impact categories. The Employment and Economic Growth impact category will provide inputs to the Public Fiscal category to determine tax base changes; will provide inputs to the Public Services category for demand changes; will receive inputs from the Public Services category for indirect employment changes; will receive inputs from the land use category relating to land development capability changes and proposed development; and will receive inputs from the Private Firm Costs category on vulnerability of firms to water quality control costs.

The second issue to be addressed in the screening concerns the selection of employment impacts to measure. This decision will largely be governed by the results of the other impact categories. If for example, it is clear from the Private Firm Costs category, that a number of firms or that firms with significant employment appear to be vulnerable to pollution abatement costs, then this issue should receive major priority. The land use analysis may indicate substantial potential for industrial and commercial development, for example, because of additional sewer capacity. This may also deserve considerable attention because of its attendant public service and tax base effects. In general, these two issues, plus direct employment increases associated with water quality controls should receive the most attention in areawide quality impact analysis.

9.4 MEASUREMENT TECHNIQUES

Direct Effects

There are two principal types of direct employment changes in the areawide water planning area associated with water quality strategies: public service jobs involving the operation, regulation, and administration of water quality control strategies; and construction jobs associated with the construction of water quality control facilities.

Public Service Jobs--

This issue may be of particular importance in an area where the strategy involves the public sector assuming a traditional private sector role (e.g., septage hauling) or conversely the private sector assuming a traditional public sector role (e.g., operation of a publicly-owned treatment works). These estimates should be readily obtainable since cost figures for the strategies have presumably taken new staffing responsibilities into account. If these figures have not been developed in the 201 plan, then existing local agencies or nearby communities will have to be consulted to develop estimates.

Construction Jobs--

Some water quality strategies, particularly sewage treatment facilities, sewer line expansion, incinerators, and stormwater facilities, will require substantial construction and thus provide additional short-term construction jobs for the area. Example 9-1 is an example of how to derive construction employment impacts for a water quality control project.

Indirect Effects

Increasing or decreasing employment in one sector of the economy will produce additional effects in other sectors of the economy. These effects are called higher-order effects. Of all the employment changes discussed in this impact categoy, these are the most speculative to determine particularly when using indirect impacts as the base for determining additional higher-order effects. Consequently, while areawide water quality agencies should be cognizant of these impacts, multiplier employment impact effects should only be calculated on very likely employment base changes.

Calculating employment changes using a multiplier is quite straightforward as shown in Example 9-2. The use of a multiplier, however, at the local level should be done cautiously because of employment leakage to the surrounding region. To obtain or estimate employment multipliers for your area for a particular industry, consult your state Department of Economic Development or the U.S. Department of Commerce's Bureau of Economic Analysis.

Accelerator Effects

Forecasting accelerator effects is difficult. Many methods, such as regression and least-cost analysis techniques, are complex for socioeconomic assessment analysis. Simple estimation techniques are suggested.

Water Quality Cost Burden Impacts--

The analysis in the Private Firm Costs impact category will have identified vulnerable firms, i.e., those firms that may respond to increased pollution abatement costs by decreasing production and emplovees or closing the firm's operation. In this impact category, the planner should determine how much employment loss is associated with these vulnerable firms. Existing employment levels for these firms can be obtained via state industrial directories, Chamber of Commerce directories, or directly from the firms. In Example 8-2 all of the firms required to institute pretreatment requirements have been initially identified as firms where employment losses could occur. Two methods may be used to determine plant

Example 9-1

CONSTRUCTION WORKER EMPLOYMENT IMPACT OF NEW SEWAGE TREATMENT FACILITY

Facility Cost = $77.9 million

Assumptions:

- *skilled labor accounts for 25% of total cost*
- *unskilled labor accounts for 40% of total cost*
- *skilled labor = $15/hour*
- *unskilled labor = $10/hour*

Person-year = 2000 person-hours

Dollar value of skilled labor = $77,900,000 x .25 = $19.5M

Dollar value of unskilled labor = 77,900,000 x .40 = $31.1M

Level of effort of skilled labor = $19,500,000 ÷ $15/M ÷ 2000 hours = 650 person-years

Level of effort of unskilled labor = $31,100,000 ÷ $10/M ÷ 2000 hours = 1555 person-years

Total Labor = 2205 person-years

Assumptions:

- *construction period = 10 years*
- *construction season is 6 months (.5 year) long*

Therefore: 2205 person-years ÷ 10(.5) actual construction time = 440 people employed during the construction period for ten years

9-2

Example 9-2

USING AN EMPLOYMENT MULTIPLIER TO FORECAST EMPLOYMENT

Actual 1980 Employment:

Basic Employment = 85,600

Service Employment = 143,100

Multiplier = 1.67

Projected 1995 Basic Employment = 125,400

1995 Service Employment = 125,400 X 1.67

= 209,635

closures or employment losses:

- Simple Survey - The most straightforward assessment method is to aggregate the cost and/or expenditure direct impact information from all impact categories into a comprehensive framework and survey the affected firms as to their response. However, it must be recognized that many firms may be reluctant to discuss impacts under any circumstances and other may do so only if confidentiality of the information is assured. Still others may be willing to release only very general information.

  In any case, the success of any survey effort can be significantly enhanced if it is conducted with the cooperation and support of industrial development organizations or private sector associations such as the Chamber of Commerce or relevant industrial development commissions. If the survey is conceived as as tool for involving the private sector in the design and implementation of a water quality management strategy, it can serve simultaneously as an informational tool, impact assessment technique, and a public participation technique.

- Interpretation of Cost Burden Information - Using the cost burden ratios developed in Example 8-2 in the Private Firm Costs impact category, the planner may make a judgment as to most significantly affected firms. Although there are no absolute values for any of these ratios which are acceptable or unacceptable across all firms, often it is possible to identify those firms which may find it difficult or impossible to bear projected costs. The shutdown of some or all of the "significantly" impacted firms may then be assumed for impact assessment purposes. These assumptions, in turn, may be used to forecast employment losses. Example 9-3 indicates the likely losses based on an analysis of the ratios and discussions with the firm's management. This one impact indicator, incidentally, lends itself, because of numerous assumptions used in the calculation, to being expressed as a range. For example, in Example 9-3 the employment loss could have been expressed as 250-300 jobs.

Changes in Location Attributes--

- Extrapolation of Case Studies of Similar Situations - When similar effects on area attributes have occurred elsewhere, the results may be used to indicate the type and magnitude of changes that may occur in the region of interest. However, extreme care must be taken in the extrapolation of experiences from another area, to discern the effect of inter-area differences on net employment impact.

- Surveys of Existing Area Firms - Existing area firms (and other firms which have previously expressed an interest in locating in

Example 9-3

UNION CITY FIRMS LIKELY TO SUFFER EMPLOYMENT LOSSES

Major Product Category	Firm Name	1976 Employment	1980 Employment	Employment Loss '76-'80
Electoplating	Advanced Plating	9	9	-
	A.A. Brunel	18	8	10
	Eagle Electroplating	14	0	14
	Edward P. Garrepy	20	20	-
	Hard Chrome Division	17	12	5
	Independent Electroplate	40	0	40
	Metal-Kote	75	65	10
	New Method Plating	30	0	30
	Qualatron Electroplating	8	0	8
	Reliable Plating	8	0	8
Plastics	Dacor Corp.	80	50	30
	Holden Plastics	50	0	50
	Produx Co.	45	45	-
	Worcester Moulded Plastics	160	100	60
		574	309	265

1976 - 1980 Employment Loss = 265

# of Firms closed = 6

the region) can be contacted to determine an estimate of their response to the change in area attributes caused by implementation of water quality strategy. Some area firms may indicate whether changes in expansion or operation plans will occur, or whether they may be induced to move either within or outside the region of interest. However, one must be sensitive to the fact that many firms are unwilling or reluctant to discuss such plans without assurances that their replies will be kept confidential. Selected firms located outside the region which have shown interest in locating in the region should also be asked whether and how the change in area attributes will affect their plans. The change in response which is attributed to the water quality management plan by company officials may be construed as the accelerator/decelerator impact of the plan. This method can be relied upon only for very rough approximations of impact.

- Simple Extrapolation of Trends - Where staff skills and financial resources are limited, simple extrapolation may be used to formulate rough approximation of accelerator growth caused by the new facility or other changes in area attributes. Using existing data, recent past trends (prior to the change in area attributes) can be extrapolated to formulate an economic growth forecast for the area. Deviations from this trend observed after area change(s) have occurred, may then be attributed to the change(s). These deviations should be calculated for the local region as a whole and its component jurisdictions. Trends may be based on gross SIC groupings (e.g., construction trade, manufacturing, etc.) or a more detailed basis. Annual employment statistics are available from state sources.

  The technique is limited. It may be more appropriate to use it in combination with simple survey techniques applied to new firms, existing firms which expand, and existing firms which move within the region. The survey may then be used to identify those firms whose plans were influenced by the change(s) that occurred.

A direct method for determining accelerated employment resulting from land development capability changes is to derive a land or floor space to employee ratio. If the land use impact analysis determines that the lack of developable land has constrained industrial and commercial employment, and sewering that land will remove this constraint, these land use impacts may stimulate development that can be attributed to the sewering project. The planner will require some type of existing employment projections for the community or region in question and some knowledge of how land use constraints have been used to develop those projections. The key issue is, however, demand. Many communities envision sewers as opening up their community for commercial development. While the sewers may remove development constraints, there still has to be a demand for development to take place.

If the demand is shown to exist, then the planner can relate the land opened up for development to projected employment gains. The best data on employment/industrial or commercial space ratios come from surveys of existing development. These ratios will vary considerably for urban and suburban areas and for different types of firms. It is therefore desirable to use a range of ratios to determine employment gains. This range of land uses will be determined by the allowable uses for the land as prescribed in the appropriate zoning by-laws. Using ratios of either existing land/employee or floor space/employee in the area, approximate projected employment gains can be made.

9.5 DATA REQUIREMENTS

Exhibit 9-2 indicates the basic data that is required in this impact category.

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Exhibit 9-2

EMPLOYMENT AND ECONOMIC GROWTH DATA SOURCES

Data Item	Data Source	Use
-Existing employment by 2 digit SIC	• Private firm costs impact category • Discussion with firms	Accelerator employment losses
-Firm response to water quality controls	• State employment agency	All of the analyses
-Existing employment for vulnerable firms	• Industrial directories • Survey of firms	Accelerator employment losses
-Direct dollar costs for structural controls	• Facilities planning on areawide water quality study	Direct construction and public service employment gains
-Employment multipliers	• U.S. Bureau of Economic Analysis	Multiplier effects
-Past and existing employment/land area ratios	• Survey of existing development	Accelerator effects

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CHAPTER 10

Private Individual Costs and Benefits

10.1 IMPACT DESCRIPTION

Impact Definition

This impact category is concerned with the direct and indirect impact of water quality control strategies on individuals--users of wastewater control programs, non-users, households, other property owners. This impact category can be considered an "end impact" category in that a variety of pollution abatement costs are distributed through other impact categories, notably public fiscal and private firm costs. The costs of water pollution control, in the final analysis, fall on individuals in their capacity as taxpayers and consumers. Local governments finance their share of pollution control costs through taxes; industries raise the prices of their products to cover their costs.

Of particular interest in this impact category will be individual cost impacts stemming from public fiscal decisions. Changes in land values are also considered. While industries also will generally pass water pollution control costs on to consumers, these types of macroeconomic impacts are not of concern here because of the focus of this guidebook on locally generated and received impacts. One type of consumer issue that may be impacted and felt locally by water quality control strategies, housing costs, is discussed in this impact category.

Impact Issues

Because of the importance of the public fiscal impact category to the magnitude and distribution of private individual costs, it is useful to briefly review the impact relationship. Public expenditures for pollution control occur directly through compliance costs associated with public pollution control strategies, such as the construction of wastewater treatment facilities or a stormwater detention pond; and through regulatory costs for such programs as erosion control and pretreatment monitoring. Indirect costs that result from water quality control stimulated public service demands may also increase public expenditures. Tax base changes associated with water quality control strategies will also affect the public fiscal revenue pattern.

User Services and Public Costs--

Revenues to pay these water quality costs may take a variety of forms. As shown in Exhibit 2-4 in Chapter 2, there are numerous public financing mechanisms available to a community that will determine how these water quality associated public costs will be distributed to users, non-users; to households; to firms. See Examples 10-1 and 10-2 for an illustration of how different methods of financing will affect sewer costs to users and non-users. Because of the close relationship between public fiscal impacts and private individual costs, it is recommended that both of the impact categories be considered together--particularly during the consideration of public financing options.

Land Value Changes--

The implementation of water pollution control strategies may also financially benefit individuals. Since any successful control strategy will enhance water quality, obvious benefits will result. Those who own houses near areas of enhanced water quality are likely to experience increased real estate values.

As stated in Chapter 1, a basic assumption that is used in this guidebook is that equal water quality improvements will result from each alternative under consideration. It is assumed that strategies that do not meet water quality standards will not be considered in the final evaluation process. One of the implications of this assumption, therefore, is that land value changes directly associated with water quality improvements are not considered in this guidebook. The water quality planner may wish to consider them, however, and several references are presented in Section 10.6 that are useful in measuring land value impacts.

Indirect land value changes resulting from other socioeconomic impacts are, however, of interest in this guidebook. For example, changes in land development capability associated with public sewers or with growth management controls is an important issues. Sensory impacts, such as noise, odors, and aesthetic concerns, associated with specific water quality strategies may also stimulate changes in land value.

Housing Cost Effects--

Housing costs, a major consumer item, may be affected by water quality strategies in a number of ways. This issue should be of particular interest

Example **10-1**

AVERAGE ANNUAL USER COSTS FOR PROPOSED SMITHVILLE SEWER PROJECT -- USER BEARS TOTAL COST

- Annual debt service for capital costs of interceptors, pumping stations, treatment plant = $300,000
- Annual debt service for capital costs of lateral sewers = $250,000
- Annual average operation and maintenance cost = $ 95,000

TOTAL ANNUAL COSTS $645,000

- Average number of equivalent users, 1980 - 2000 = 6,210
- Average annual costs/user = $103.86

- Average 1978 Smithville Household Median Income = $9,300
- Average Annual User Cost/Household Median Income = 1.12%

Example 10-2

AVERAGE ANNUAL USER COSTS FOR PROPOSED SMITHVILLE SEWER PROJECT -- USERS AND ALL HOUSEHOLDS SHARE THE COST

	User/All Households Share
• Annual debt service for capital costs of interceptors, pumping stations, treatment plant = $300,000	$210,000(.70) / $90,000(.30)
• Annual debt service for capital costs of lateral sewers = $250,000	$225,000(.90) / $125,000(.10)
• Annual average operational and maintenance costs = $95,000	$ 76,000(.80) / $19,000(.20)
	$511,000 / $134,000

Average number of households, 1980 - 2000 = 10,000

Property tax levy to all households = $134,000 ÷ 10,000 = $13.40/yr.

Average number of equivalent users, 1980 - 2000 = 6,210

Average annual costs/year:

User charge = $82.28

Tax levy = $13.40

TOTAL USER COST = $95.68

in impact assessment because housing is generally a costly purchase for individuals. The cost of housing is the summation of a number of costs incurred by the land developer and home builder. These costs can be broken into several components, such as those shown in Exhibit 10-1.

Land costs are affected by environmental regulations which effectively reduce the supply of available land. However, these costs are fixed prior to the development process. The cost of unimproved land is affected by a variety of factors, including:

- accessibility of the land to employment centers and amenities;
- its physical developability in terms of natural features and constraints;
- land use regulation; and
- demands for land for various activities through population and economic growth.

The most significant of these factors affecting the price of land--demand (as represented by population and economic growth)--is tempered by the other variables listed above. The other factors constrain or enhance the desirability of the land for development. For example, the availability of public sewers or public water increases the developability of land. Similarly, land that is characterized by severe slopes, wetlands, or other natural features may be expensive or physically difficult to develop, and thus more costly.

Land use regulations may affect the cost of land by limiting its supply. There are several ways in which land use regulations affect the supply of land:

- Amount of Land: Land use regulations affect the amount of land "available" for development by the limitations placed on development. For example, large lot zoning may take affected land out of the market for most types of development. Similarly, zoning land for agricultural uses may remove land from development.
- Type of Land: Regulations, particularly those with environmental considerations, affect which type of land is in the land development market.
- Location of Land: Regulations, particularly those geared to yearly quotas of availability of public services, may affect land available for development.
- Timing: Land use regulations may be used to limit the supply of land available for development at any one time. Communities consciously pursuing a "staged development" approach will use

investments in public facilities to supplement land use controls.

Land development costs, as shown in Exhibit 10-1, consist of both administrative costs, such as permit fees and engineering studies, and costs associated with compliance with regulations. A developer will typically face two types of financing costs in the development process--land development financing and construction financing. These costs are subject to the base amount borrowed (the cost of the land and of the construction materials and labor) and prevailing market interest rates. These financing costs are typically referred to as the "carrying costs" of development. Carrying costs are, of course, affected by the length of the development process. Consequently, water quality regulations, such as erosion control review time, that affect the length of the development process will tend to increase a developer's carrying costs.

Finally, construction costs comprise the last component of the developer's housing costs. House construction costs consist of the materials and labor required to build a house. Construction costs are the largest component of the cost of a house. These costs typically run to 60-75% of the total cost of a house.

Water Quality Strategies can directly affect these components of housing costs in three days. First, regulations can require the developer to study the proposed site, to identify impacts, and to develop mitigation measures for environmental problems. These costs are incurred while the project is reviewed by permitting agencies, and costs can increase when changes to project plans are required. This first type of cost is administrative in nature, and affects the planning expenditures which are part of the land development cost component shown in Exhibit 10-1.

The second area of impact concerns carrying costs. These are related to administrative costs, and are incurred as environmental regulations increase the time required for the developer to obtain the necessary approvals. Delays in the development process primarily affect costs incurred in financing land development, directly through property taxes and insurance paid during the period in which environmental problems are settled. If the delay period is sufficiently long, then the developer can also incur inflation costs as the prices of building materials and labor rise. The costs of construction financing may also be affected if water quality requirements top or slow a project for which ground has been broken.

The third area of impact lies in the costs associated with compliance with mitigation requirements of water quality regulations. This type of cost includes, for example, the construction of additional sewerage capacity or the cost of a stormwater detention pond. In the case of development which must be reduced in scale because of water quality problems, these costs represent the loss to the development of the portion of the plan that could not be built. In terms of the cost typology presented in Exhibit 10-1, these compliance costs affect land development activities (e.g., construction of roads and other site improvements) as well as changes in the

Exhibit 10-1

HOUSING COST COMPONENTS

- Land: the purchase price of "unimproved" land prior to removal of cover, grading or the provision of services;
- Land Development: cost of planning, permitting land clearance, installation of utilities and roads, and measures employed to mitigate the environmental impacts of site preparation activities;
- Land Development Financing: interest costs on funds borrowed for land purchase and development;
- Construction: costs of materials and labor inputs in the construction of dwelling units;
- Construction Financing: interest as funds borrowed for construction activities.

169

amount of building materials and labor required for the construction of the houses themselves.

Environmental regulations also have an indirect impact upon the costs of housing, through pollution control requirements imposed upon manufacturers of materials used in construction. These indirect or input costs represent a fourth category of impact, but are not considered since our focus is on local costs resulting from local water quality strategies.

10.2 IMPACT INDICATORS

The impact indicators in this impact category are straightforward. It is useful to structure the indicators along the impact issues discussed above. The types of indicators that can be used include:

For direct water quality-related user services:

- changes in household connection fees;
- changes in household user charges;
- water quality-related costs as a percentage of annual household income.

For other water quality-related public costs and for indirect public service costs:

- changes in per capita and household tax burden;

For indirect land use and nuisance effects:

- changes in real estate values.

For water quality cost impacts on housing:

- changes in per unit housing costs.

The first category of impact indicators primarily involve domestic wastewater service and are of particular interest since these can be the most burdensome to individual households. As discussed in Secton 10.3, EPA now requires that annual wastewater treatment user costs also be expressed in terms of median household income to reflect actual cost burden.

10.3 PRELIMINARY CONSIDERATIONS

EPA's Program Guidance Memorandum 79-8 mandates that annual wastewater treatment user costs be expressed as a percentage of median household income. This is considered by EPA to be an essential component of a financial capability analysis for wastewater facilities. Estimated user costs are calculated after determining the local share of funding discussed

170

in the Public Fiscal impact category in Chapter 7. When total annual user costs for wastewater facilities (including debt service, connection costs, operation and maintenance) exceed the following percentages of annual household median income, EPA considers the project "expensive":

- 1.0% when annual median income is under $10,000
- 1.5% when annual median income is between $10,000 and $17,000;
- 1.75% when annual median income is over $17,000.

If you have identified a project as expensive under these guidelines, you should be prepared to undergo intensive EPA review. You may wish to recalculate your costs and financing methods to check their accuracy or alter the project.

Another issue to consider in this impact category is the amount of time to spend on calculating housing cost impacts. Before embarking upon this analysis which can be very time-consuming, you should carefully consider the links between the proposed water quality strategy and housing costs. A recent study (USR&E, 1981) of the effect of Federal environmental regulatory costs (includes the Clean Water Act, the Clean Air Act, and six other environmental laws) indicated that Federally-mandated environmental costs accounted for only 2.3% of the cost of the selling price of a housing unit in 9 case study areas. About 70% of this 2.3% was attributable to pollution control costs in building materials used in the construction of a house. Thus, less than 1% of the housing cost was attributable to local implementation of Federal environmental regulations. Because of the amount of resources it takes to estimate housing cost effects, we do not recommend that you proceed with these impact issues without carefully considering the importance of housing cost issues to the overall socioeconomic assessment.

As a means for screening the impact of water quality strategy on housing costs, consider Exhibit 10-2 which outlines a fairly typical breakdown of housing cost conponents. This breakdown of costs is typical even though the actual housing price may vary in your area. As seen in this exhibit, the largest cost category typically present in total housing costs is the materials and labor category under house construction. This is generally the one area not affected by local water quality strategies. Water quality strategies tend to affect land costs, land development costs, and carrying costs as seen in Exhibit 10-3. Thus, if you start examining the incremental effects of water quality strategies on these cost categories, you will find that the overall housing cost increases attributable to water quality strategies will generally be relatively incidental.

10.4 MEASUREMENT TECHNIQUES

Direct Water Quality-Related User Services

The first requirement for measurement is that total costs--both capital

Exhibit 10-2

TYPICAL HOUSING COST COMPONENTS

Component	Cost	%
• Land	$4,000	5.7%
• Land Development		
-- Bond & Permit Fees	2,200	3.1
-- Improvements	7,000	10.0
• Carrying Costs		
-- Land financing	2,000	2.9
-- Construction financing	4,000	5.8
• House Construction		
-- Materials & Labor	47,000	68.1
-- Miscellaneous other costs	3,000	4.3
TOTAL	$69,200	100.0%

SOURCE: Seidel, Stephen. R. Housing Costs and Government Regulation: Confronting the Regulatory Maze. Center for Urban Policy Research, Rutgers University, 1978.

Exhibit 10-3

WATER QUALITY STRATEGY IMPACTS ON HOUSING COSTS (examples)

Water Quality Control Strategy	Affected Housing Component
● On-site wastewaster management ● Growth management controls ● Centralized sewerage systems	Land Costs
● Erosion control compliance improvements ● Stormwater management compliance improvements	Land Development Costs
● Regulatory review requirements associated with stormwater control, erosion control, sewers, on-site wastewater management	Carrying Costs

and operational--be available. The capital costs must be converted into annual debt service costs such that a total annual cost of a project can be established. User costs can then be determined as shown in Example 10-1. It should be noted in Example 10-1 that the average number of equivalent users is a critical number. Built into that number are assumptions regarding the expansion of the sewer system to add new users. In reality, there will be fewer than 6210 users at the early stages of the project and thus there will be higher user costs during that time.

More than likely one of the key issues to be addressed in this type of water quality strategy is the distribution of costs to users and non-users. For example, traditional sewer financing assumes that some non-users benefit from sewers and thus should pay a portion of the costs. The type of benefits that accrue to non-users include for example, community-wide benefits associated with sewering public buildings. Example 10-2 illustrates the distribution of costs when a portion of the costs are financed through ad valorem property taxes.

Water Quality-Related Public Costs

As seen in the above example, there may be a change in tax burdens for non-users of a public sewerage system. Additional tax burdens will largely stem from public service demands and from the public costs associated with regulating and administering a variety of water quality control strategies. It is possible to aggregate all of these separate water quality-related costs in evaluating alternatives. See Example 10-3.

Changes in Real Estate Values

The two principal impact issues of interest here are water quality strategy nuisance-related effects of property values and increases in property values associated with sewer-related changes in land development capability.

Several types of nuisance effects are discussed in Chapter 15. They include noise, visual, and odor impacts from water quality control structures, such as sewage treatment facilities, incinerators, and stormwater detention facilities.

Sewers may affect land development capability by increasing the wastewater carrying capacity of the land, transferring the capacity constraint off-site, to another area. Wastewater carrying capacity is, however, just one of many other natural and physical constraints that affect the ability of land to support development. In addition, regulatory constraints, such as zoning controls, and other infrastructure controls, such as water supply availability, may also affect land development capability.

The ability to measure the impacts of water quality control strategies on property values is hampered by the complexity of components that shape a

Example 10-3

HOUSEHOLD TAX BURDEN IN SMITHVILLE ASSOCIATED WITH ALTERNATIVE WATER QUALITY STRATEGIES

Water Quality Issue	Alt. A	Alt. B	Alt. C
• Public Sewerage	$\boxed{\$13.40}$	\$5.00	\$0.00
• Erosion Control	.90	1.20	$\boxed{1.00}$
• Industrial Wastewater Monitoring	$\boxed{.75}$	.60	.20
• Stormwater Management	1.20	$\boxed{2.00}$	4.50
• On-Site Wastewater	2.60	$\boxed{1.90}$	2.50
• Indirect Public Service Demands	$\boxed{1.90}$	4.00	.90

□ = Alternatives chosen by Smithville

Total Tax Burden Associated with Water Quality Management = \$20.95

Water Quality Tax Burden Costs/Total Tax Burden =

$$\frac{20.95}{290.75} = .07$$

property's value. These include accessibility, site characteristics, nearby development, street patterns, and general demand for property in the area.

Despite the use of regression approaches and other modeling techniques, the available literature has not derived reliable techniques for predicting property value impacts resulting from water quality controls. The water quality planner can use two approximate methods to derive crude estimates. One approach, the similar site method, attempts to compare two sites with comparable characteristics. Only the presence of the water quality strategy in one of the areas distinguishes the two sites. Differences in property values are then attributed to the water quality control strategy. This method is not entirely reliable because of the great difficulty in finding similar sites. It is also time-consuming for areawide planning efforts. A second approach, the key informant or expert opinion method, relies on the opinion of an expert familiar with property values in the area. Two types of experts are suggested: real estate agents and local tax assessors. Real estate agents are more likely to be willing to estimate, at least in ordinal terms, property value effects associated with specific water quality strategies.

Water Quality Cost Effects on New Housing Costs

Step 1: Determine Existing New Housing Cost Components

In order to determine the incremental effects of water quality strategies on housing costs, you should first determine the typical housing cost components of new housing in your area. You should end up with a table similar to that in Exhibit 10-2. To develop this table, you should talk with the local or regional association of builders, local realtors, and local developers. This step should also establish the existing nominal development process in the area: the role of regulatory agencies and the time period for the development process (planning and construction).

It will probably take 1-2 person days to establish a fairly reliable cost breakdown and development process if they have not been already established.

Step 2: Determine Water Quality Strategy Link to New Housing Costs

The basic activity in this step is to examine what aspects of the water quality strategy will likely affect housing cost components. The best approach for doing this is to consider the strategy in terms of the following cost issues:

Administrative costs: will the strategy entail additional planning and engineering requirements?

Carrying costs: will the strategy result in increased development time because of additional reviews?

Compliance costs: will the strategy require actual improvements or changes in the way land is developed?

Land costs: will the strategy affect the supply of land by limiting the amount, type, and location of land that can be developed; or by affecting the timing of land development?

Step 3: Estimate Water Quality Cost Impacts

After establishing which housing cost categories will likely be affected, you should determine the water quality cost-related impacts for each housing cost category. These costs should be estimated in per unit figures. Administrative costs should be relatively easy to estimate if the water quality strategy is reasonably well-defined.

Carrying costs are more problematic. Carrying costs should include property taxes, insurances and financing costs; and inflation costs. You will first need to establish the nominal development period from Step 1 and calculate monthly typical property tax, insurance, and financing costs for constructing new houses. Current monthly inflation estimates applicable to housing can be obtained from the construction cost indices published by the Engineering News Record (ENR). Take the last 6 months of the ENR and estimate the average monthly inflation for housing construction costs.

At this point to determine the impact of a water quality control strategy on carrying costs, your should multiply the increase in the development period (in months) associated with the water quality strategy times the sum of the above monthly carrying costs for typical new house construction in the area.

Compliance costs for such items as erosion controls, stormwater detention ponds, or new on-site wastewater management requirments should be developed from other field experience on from state or EPA data. Costs may only be available for erosion and stormwater control on a per acre basis and will thus have to be converted (using existing land use requirements) to per unit housing costs.

You should consult with local realtors to estimate the effect of the water quality strategy on per acre land costs. These are the most difficult and speculative costs to estimate. These costs will also have to be converted into per unit housing costs.

Step 4: Summarize Costs and Compare to Existing Costs

This step simply requires you to aggregate the individual costs, such as those shown below, and express this total cost impact as a percentage of existing housing costs. For example, a proposed on-site wastewater management program for Smithville will result in the following incremental housing costs:

Administrative:	$75/unit
Carrying Costs:	$360/unit
Compliance Costs:	$250/unit
Land Costs:	$500/unit
Total Costs	$1185/unit

Existing new housing in Smithville costs $77,600; thus the impact of the proposed water quality strategy is approximately 1.5%.

10.5 DATA REQUIREMENTS

Data sources for this impact category are listed in Exhibit 10-4.

10.6 REFERENCES

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Exhibit 10-4

Data Item	Data Source	Use
- Water quality control costs	• 208 Study	Direct user costs
- Latest annual household median income by County	• U.S. Census • Annual Survey of Buying Power, Sales and Marketing Magazine, August Issue	User cost burden analysis
- Households/housing units	• U.S. Census; and building inspector	Tax burden analysis
- Existing tax rate	• Tax assessor	Tax burden analysis
- Existing and projected real estate values in selected areas	• Tax assessor • Real estate agents	Property value analysis
- Average new housing component cost	• Builders, developers • Real estate agents	Housing cost analysis
- Construction cost indices	• Engineering News Record	Housing cost analysis

179

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CHAPTER 11

Land Use, Housing, and Population

11.1 IMPACT DESCRIPTION

Impact Definition

Over the past 5-10 years, no environmental assessment issue for wastewater treatment facilities has provoked as much discussion as the issue of growth impacts. This chapter focuses on several growth impacts that are associated with water quality strategies. Included in the discussion are the impact issues of housing and population effects.

Land use, housing, and population impacts, as used in this guidebook, include changes in the: amount of growth, location of growth, type and density of growth, and the timing and rate of growth.

Impact Issues

While growth effects dominate the discussion in this chapter, there are a number of impact issues that fall within this impact category.

Land Pre-emption--

Many water quality projects are land intensive or compete for land with other land uses. In short, conflicts can develop between the land needs of water quality strategies and the land needs of competing uses. An additional issue that often is lurking behind the land pre-emption issue is the one of tax base loss. In most cases, new water quality control facilities will involve the removal of private tax-paying land from the tax rolls. Water quality strategies that are land intensive include: land application systems, other large municipal and regional wastewater facilities, large stormwater detention ponds and lakes, and large combined sewer overflow (CSO) facilities.

In examining this issue, however, the water quality planner should not limit the analysis to only land intensive facilities. Smaller facilities will also stimulate this issue when the competition for land in an area is strong. For example, land zoned for industrial uses is a prime area for wastewater facilities. The notion behind this siting concept is to avoid sensory conflicts with residential and other uses. Using industrially-zoned land for water pollution control facilities, however, pre-empts future industrial land use. The extent to which this conflict and other conflicts involving competing uses, such as potential recreation areas near water side areas, is an issue in an area will depend on the type of facility and the level of competition for certain land uses.

Land Reclamation--

This beneficial impact applies primarily to one type of water quality strategy, namely land applicaton of wastewater effluent or sludge. In the case of effluent, it can be used to irrigate or fertilize arid land. By stimulating vegetation growth, new uses may be possible for the land - including hunting (actually the case in Muskegon, Michigan), farming, or park land. Similarly, wastewater sludge can be used to fertilize land, and, in the case of barren land such as abandoned strip mining areas, actually reclaim the land for productive uses. A recent study (see USR&E, December 1980) has compiled a number of cases where sludge has been successfully utilized to reclaim land.

Changes in Land Developability--

One of the most important issues in this impact category is the effect of wastewater control strategies on land developability. The ability to develop land is generally governed by two factors: 1) natural development constraints; and 2) land use regulations which control the type, density, and timing of development. One of the natural development constraints facing land development is the ability of the land to accept wastewater from on-site wastewater systems. There is a natural development density for land based on its wastewater management carrying capacity. Centralized sewers act to remove the wastewater development constraint and shift it to the location of the centralized wastewater treatment facility. In essence, the wastewater carrying capacity of the land is now off-site: 1) the treatment capacity at the disposal point (either land or water) for the centralized wastewater facility; and 2) the sewer lines that transport wastewater from the developed land. Because of their dramatic effect on land carrying capacity, wastewater facilities may also indirectly affect regulatory constraints on land development. The increased carrying capacity is a very strong factor in getting land re-zoned to more intense uses (residential to commercial) or to higher density uses (single-family to multi-family).

132

The financing method for wastewater systems is also an important determinant in shaping growth impacts. For example, one means of financing the local share of capital costs is the use of betterment assessments on all property abutted by sewer lines. This betterment assessment when applied to vacant sewered land provides further stimulus for development.

Generally, a community will employ three types of revenues to fund different portions of a sewerage system: user (or service) charges, connection fees, and property taxes. User charges, in the form of lot size and frontage assessments, are frequently used to fund collection sewers. This type of charge increases the carrying cost of vacant sewered land or its rent and may stimulate land conversion or development at a higher density than without sewers. Where user charges are used to fund a large amount of excess capacity, existing users may have a a particularly high financial burden. In these cases, there may be a tendency on the part of the community to alter land use regulations to encourage growth and pay off the local share of the treatment plant and interceptors.

For new development, communities will generally require developers to pay for collection sewers. If these costs are substantially greater than on-site wastewater costs, developers may shift demand to non-sewered areas. For sewer costs to be less, the density is a key factor since collection costs are highly correlated to front-footage. The land use implication is that density changes may have to occur in land use regulations in order for development to take place.

Different types of wastewater investments will have different effects on land developability:

- In unsewered areas undergoing sewering, both treatment plant capacity and service area location will affect land developability.
- In sewered areas where treatment plant capacity is being increased, there will be increased pressure to develop sewered vacant land.
- Sewer line extensions, i.e., service area changes, will primarily affect previously unsewered vacant land areas.
- The type of staging policy used, i.e., the design period and the reserve capacity, for both the treatment plant and interceptors may significantly affect the timing of land development. Excess capacity tends to reinforce land development in areas where there is demand for development. In the service area provided with excess capacity, land development may be accelerated. On a regional basis, development demand may shift to service areas with excess capacity. The lack of capacity in sewered vacant areas may force new development to outlying vacant land areas where on-site systems are possible.

In addition to affecting land developability directly through structural wastewater investments, water quality strategies may involve regulatory mechanisms that also affect the developability of land. Examples include: growth management controls, such as large lot zoning, cluster zoning, sensitive area zoning, and wastewater moratoria. In unsewered areas, on-site wastewater management regulations will affect lot sizes and thus land developability.

Growth Pattern Changes--

Changes in land developability, in concert with other factors, may trigger changes in an area's growth pattern. As seen in Exhibit 11-1, however, there are a number of factors that influence growth patterns. Public facility investments in the form of centralized wastewater facilities will influence land developability (which is considered a natural constraint in the exhibit). But there are other "supply" and "demand" factors that also influence growth patterns. As mentioned above, local and state land use policies and regulations are significant forces affecting the supply of land for development. On the demand side, regional growth forces, such as population migration, the location of employment centers, the location and type of transportation networks, and the attractiveness of neighboring communities -- all will affect the demand or pressure for development in a community.

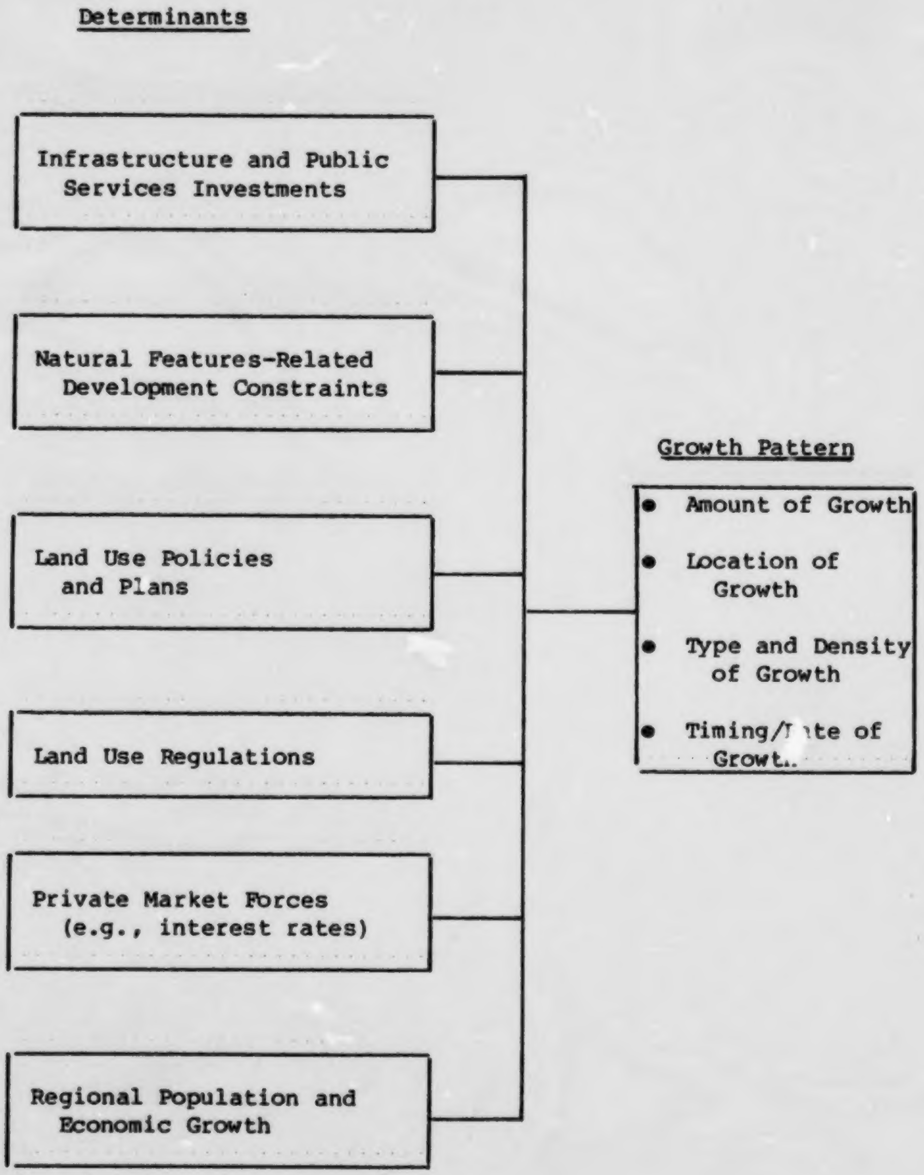
Several determinants interact, as seen in Exhibit 11-1, to shape growth patterns. Consequently, the impact of wastewater facility investments, discussed above, on land developability may not automatically translate into growth pattern changes. Wastewater facility investments are likely to alter the balance between supply and demand factors that affect local growth patterns. The extent to which this shifting of supply and demand will result in growth pattern changes is the key issue. Section 11.4 below discusses the type of situations where wastewater facility investments will have a high potential for changing growth patterns.

Exhibit 11-1 illustrates the generic growth impacts potentially associated with wastewater facilities. More specifically, some of the potential adverse impacts include:

- A significant increase in the development and population growth rate of a community;
- A significant increase in multifamily development in a community traditionally characterized by single-family development;
- Development of valued areas, such as open space, agricultural land, waterside areas;
- Development in environmentally-sensitive areas, such as steep slopes, flood-plain areas, and wetlands;

Exhibit 11-1

Growth Pattern Determinants


Determinants
Infrastructure and Public Services Investments
Natural Features-Related Development Constraints
Land Use Policies and Plans
Land Use Regulations
Private Market Forces (e.g., interest rates)
Regional Population and Economic Growth
Growth Pattern
• Amount of Growth
• Location of Growth
• Type and Density of Growth
• Timing/Rate of Growth

It should also be pointed out that wastewater investments may have very positive growth impacts on a community. This statement points to the importance of local attitudes towards growth and development in assessing growth impacts. For example, in urbanized areas, the additional development capacity brought by sewers may be viewed very positively because of the impacts of new development on the tax base.

Housing and Population Impacts--

In addition to these direct growth effects, many communities may suffer adverse indirect effects from growth, particularly in terms of public service impacts. Important links between growth changes and public service impacts are changes in housing and population. In both cases, impacts of concern are largely related to the general growth issues discussed above, namely, the amount, type, location, and rate of changes. Public service impacts are sensitive to each of these types of changes in both the housing and population impact categories. For example, if sewers open up a large undeveloped area, the new development may have significant impacts on schools, recreation facilities, and fire station locations. In general, if development occurs outside of existing established service areas, the marginal costs associated with serving the population will be higher than if the new population is located within the existing service areas.

Rapid population changes can also create havoc with public services. A community's infrastructure in some cases cannot absorb the costs associated with accomodating rapid population changes. Legal limitations on local indebtedness generally constrain communities in the rate at which they can expand public services to meet population growth.

Growth Pattern Impacts Summary--

1. Wastewater investment impacts on developable land are only one determinant of growth patterns. Others that also effect population and employment migration to an area include:

- regional population and economic growth;
- private market forces within and outside the area;
- land use regulations and policies;
- other natural features-related development constraints;
- other infrastructure and public services.

2. Wastewater investments can impact development patterns in an area by affecting the:

- amount of growth;

- location of growth;
- type and density of growth;
- timing and rate of growth.

3. Specific characteristics of wastewater investments will affect the type of development impacts including:

- System size
    - -treatment facility
    - -interceptors
    - -collection system;
- Type of available treatment;
- Service area;
- System expansion and staging;
- System financing.

11.2 IMPACT INDICATORS

Impact indicators, while potentially numerous, are fairly straightforward. For land pre-emption issues, the indicators should convey the amount and type of land pre-empted, and in some cases, the location. Typical indicators, then, might be:

- Number of acres of town forest lost;
- Number of acres of prime industrial land pre-empted; or percentage of industrial land in community pre-empted;
- Number of river-miles of shoreland pre-empted.

Similarly, land reclamation indicators can be expressed as follows:

- Number of acres of barren scrub land reclaimed;
- Number of acres of abandoned coal strip-mined areas reclaimed;
- Number of abandoned granite quarries reclaimed.

Land developability indicators can be expressed also in terms of amount, type and location of land of affected. For example:

- number of acres of vacant residentially-zoned land proposed for sewering;

187

- increase in acres of developable multi-family-zoned land;
- increase in acres of developable industrial land in a community.

Growth pattern changes represent the end impacts of land developability changes. Impact indicators should focus on changes in land use acreage.

The types and level of detail of land use categories will vary, of course, by the type of development in a community, existing land use data, and the type of development concerns in the impact area. Suggested minimum land use categories are shown below:

Land Use Indicator Categories

RESIDENTIAL

- Low density (1.0 dwelling UNITS/acre)
- Medium density (1-4 dwelling UNITS/acre)
- High density (4 dwelling UNITS/acre)

These may be altered to densities more appropriate to the impact area.

COMMERCIAL

INDUSTRIAL

- Warehousing
- Manufacturing
- Extractive

PUBLICLY-OWNED LANDS

- Developed (recreation, municipal buildings, schools, etc.)
- Open space recreation/conservation

SEMI-PUBLIC

- Developed (churches, commercial recreation, hospitals, etc.)
- Open-space recreation (golf courses)

Land Use Indicator Categories (continued)

SEMI-PUBLIC (continued)

- Utility easement

AGRICULTURE

- crop
- dairy
- timber

VACANT

- Developable
- Undevelopable
    - -Wetlands
    - -Floodplains
    - -Other constraints

More specialized land use categories can be used depending on the area. For example, you may want to disaggregate recreation or agriculture areas (particularly prime agricultural land) into finer categories.

Typical impact indicators for this impact issue would include:

- Amount in acres of increase in single-family residential land;
- Percentage increase in single-family residential land;
- Amount of vacant land converted to multi-family development;
- Amount of prime agricultural land adjacent to proposed sewer service areas.

Housing and population indicators are also pretty straightforward. The one's most suitable for areawide water quality and facilities planning are:

- Increase in number of new housing units by type - single-family, multi-family, seasonal, mobile homes, etc.;
- Percentage changes in local housing stock composition by above types;

- Increases or percentage changes in total population for the planning areas;
- Increases or percentage changes in the number of households.

While it might be interesting to measure changes in the age-sex cohorts of the planning area population, this information is difficult to estimate.

11.3 PRELIMINARY CONSIDERATIONS

Because of the interest in this impact category at the local level and the potential time-consuming nature of the issues, it is paramount that the water quality planner screen for important issues in this impact category. This screening process should include:

- Discussions with local and area planners to determine the important growth issues in the planning area; to determine likely without project trends; and to determine availability of land use data.
- Discussion with land use regulatory bodies and other local officials to determine land use and development goals for the planning area; existing policies, plans and regulations; and sensitive growth issues.

Where appropriate, special attention should also be given to screen the importance of agricultural land conversion issues. In accordance with EPA's Policy to Protect Environmentally Significant Agricultural Lands, impact assessments are required to address impacts on significant agricultural land. Specifically, the potential for wastewater management investments to trigger the conversion of land to development use needs to be assessed. In general, environmentally significant agricultural lands identified by EPA and the U.S. Department of Agriculture (USDA) include:

- prime farmland
- unique farmland
- additional farmland of statewide importance
- additional farmland of local importance
- farmlands in or contiguous to environmentally sensitive areas
- farmlands of waste utilization importance
- farmlands with significant capital investment in erosion and nonpoint pollution control plans

The screening process should also involve a discussion with EPA regional staff on the current status and interpretation of EPA policy on land use and population issues. Of particular importance is any supplemental regional policies interpreting EPA's cost effectiveness guidelines contained in 40CFR 35 Appendix A. Key issues to discuss with EPA include the following items related to flow forecasts:

- Approvable or accepted population projection for the planning area;
- Domestic wastewater flow estimation method;
- Industrial flow estimates, particularly future flows;
- Staging policies for both treatment facilities and interceptors;
- Amount of allowable reserve capacity.

11.4 MEASUREMENT TECHNIQUES

Land Pre-Emption

Step 1: Determine land requirements for proposed water quality strategy

For specific proposals where plans have been developed, this task will be straightforward. For less developed strategies, it may be necessary to develop approximate land requirements using data from EPA publications and manuals, such as the Areawide Assessment Procedures Manual.

Step 2: Evaluate proposed facility sites

For specific proposals and strategies, this step should determine any conflicts between the proposed control strategy use and other planned uses. To determine conflicts, local land use plans should be examined and local officials should be consulted. Specific conflicts to be screened include: land zoned or proposed for industrial uses; desirable recreation sites; land critical to other public uses, such as elderly housing, municipal landfill, open space, etc. The planner should determine whether the proposed facility would involve a temporary or permanent use of the land and whether the facility would be likely to expand requiring more land. For general strategies where no specific site is recommended, such as recommendations for stormwater detention ponds, the site requirements will vary depending on the type of development. In this case, proto-type examples, using EPA manuals, should be developed to determine the potential magnitude and significance of land pre-emption.

Land Reclamation

For this issue, you will need to have two basic pieces of information: 1) the amount of effluent or sludge proposed for land application;

191

and 2) the site proposed for land application. This information should be available from the description of the proposed land application strategy.

In reviewing the proposed land application strategy, you may want to check the assumptions used to estimate the land area proposed for reclamation. In particular, review the loading rates and estimated period for revegetation of the proposed site. Basically, you will want to determine when the proposed site will be reclaimed -- 5 years, 10 years, or 15 years from the start of application. The actual time when the site is ready for re-use will be important in evaluating the value of the reclamation impact.

Land Developability/Growth Pattern Changes

The measurement of growth impacts from wastewater investments cannot be done in a scientific manner. Determining induced growth impacts is not a science -- the process requires considerable planning judgement. There are several land use forecasting methodologies that have been developed and used in a variety of planning situations. For instance, there are gravity models or residential location models that attempt to factor in various residential location attributes such as accessibility to employment centers, housing costs, and housing and land availability. The Dynamic Land Use Allocation Model III (DYLAM III) is capable of incorporating sewer service areas as an input in simulating land use pattern impacts (EPA, Areawide Assessment Procedures Manual, 1977). Sewer investments and land use impacts have been modeled in several case studies using a land use simulation model developed for an EPA research project (Bascom, et al., 1975). While these models provide planners with relatively sophisticated approaches to impact assessment, they require extensive data collection, calibration, and skills to properly use.

Outlined below are two approaches that can be used in many areawide water quality and facility planning efforts. The first approach, the GEMLUP Model, uses a series of predictive equations to estimate land use impacts. The GEMLUP Model also has an air quality emissions component which uses the land use impacts to estimate air quality changes resulting from induced development. The GEMLUP approach is summarized below. The predictive equation worksheets are not reproduced in this document because of their length.

The other approach presented is called the REGION I approach since it is derived from a procedure developed for EPA Region I. This approach is basically a series of analytical steps that allow the user to estimate land use impacts resulting from wastewater facilities.

Other procedures similar to the REGION I approach have been developed but they are not significantly different in approach. The user should consult a recent publication by Urban Systems Research and Engineering, Inc., Air Quality Reviews for Wastewater Treatment Facilities: A Guidebook

192

on Procedures and Methods (full reference in Section 11.6) for a summary and explanation of the other land use impact techniques.

GEMLUP Model--

The GEMLUP Model, shown in schematic form in Exhibit 11-2, evaluates changes in air quality resulting from induced development through the use of predictive land use equations. The procedure estimates total land use from all development in a community 10 years after construction of a wastewater treatment project. This impact assessment procedure has been formalized into a set of worksheets which allow the user to assess the land use impacts associated with new or expanded wastewater facilities. The worksheets are available in the following publication: Guldberg, P. and D'Agostino, R., Growth Effets of Major Land Use Projects (Wastewater Facilities); Volume II: Summary Predictive Equations and Worksheets, EPA-450/3-78-0146, Research Triangle Park, NC, May 1978.

GEMLUP is not a general land use model; it is only applicable to an area of analysis where a major wastewater project of a certain size range will be (or already as been) built. Use of the model worksheets should be limited to situations in which the project and areas of analysis are in the size and time ranges specified below:

- A major project is defined as the construction or extension of interceptor or collector sewer lines in a community that leads to an increase in absolute system collection capacity of between 1.0 and 100.0 million gallons per day.
- The area of analysis is defined as the legal service area of the project in the base year, and it must contain a significant amount of vacant, developable land. It should be between 5,000 and 75,000 acres in area (8 to 115 square miles or 200-300 square kilometers).
- The year t, or year of initiation, corresponds to the year the major project's new or expanded collection system first carried wastewater flows. If completion of the project was (or is to be) phased, it should be completed before the year t + 5.

Projections of land use in the area of analysis are for ten years after the initiation of the project. A copy of two of the completed worksheets are shown in Exhibit 11-3.

The data requirements for the CORE land uses of the GEMLUP model are summarized in Exhibit 11-4. The variable names used are defined in English units; data sources are also listed. Some data will be easy to obtain because they are available from the wastewater treatment facility owner or operator; this is particularly true of "major project" variables, such as collection system capacity and peak flow. Other data may be difficult to

193

Exhibit 11-2

OVERVIEW OF THE GEMLUP LAND USE AND AIR QUALITY IMPACT ASSESSMENT PROCEDURE

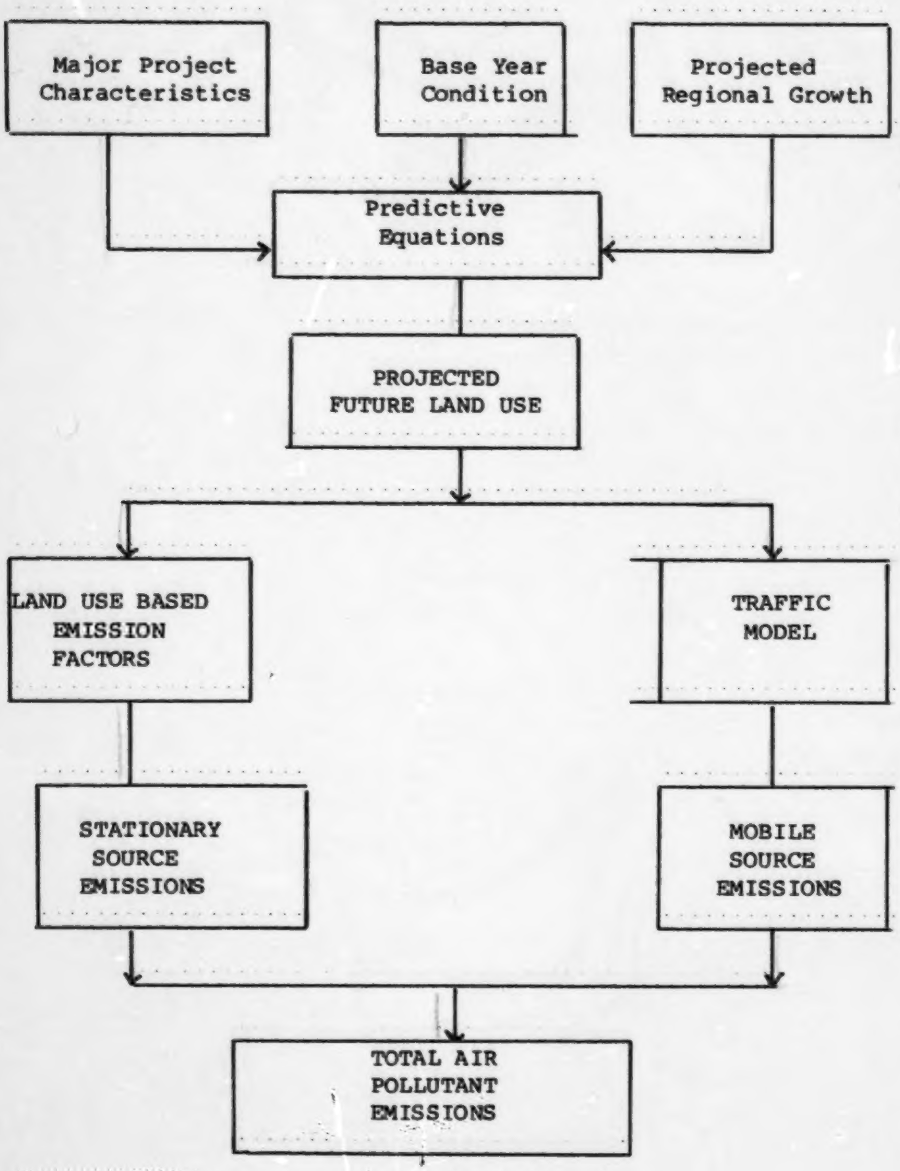

Major Project Characteristics
Base Year Condition
Projected Regional Growth
Predictive Equations
PROJECTED FUTURE LAND USE
LAND USE BASED EMISSION FACTORS
TRAFFIC MODEL
STATIONARY SOURCE EMISSIONS
MOBILE SOURCE EMISSIONS
TOTAL AIR POLLUTANT EMISSIONS

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Exhibit 11-3

Example GEMLUP Worksheets

Variable Name	Value/Computation		Inputs to Worksheets	Units
Office Zoning	= Zoned Office ÷ Area of Analysis	=	☐	*
House Density	= 100* Dwelling Units ÷ Tract Area	=	☐	Dwelling Units Per Square Mile
Zoned Industrial	________			Acres
Industrial Zoning	= Zoned Industrial ÷ Area of Analysis	=	☐	*
Population Growth	________	=	☐	*
Office Vacancy	________	=	☐	*
Airport Distance	________	=	☐	Miles
Office Workers	________			Employees
Office Employees	= Office Workers ÷ Tract Area	=	☐	Employees Per Square Mile
Future Population	________			People
Employee Ratio	= Future Employment ÷ Future Population	=	☐	*
Unemployment	________	=	☐	*
Future Income	________		☐	$
Government	________		☐	Millions of $
Collection Reserve	= Collection Capacity - Peak Flow	=	☐	Million Gallons Per Day
Interceptors	________			Miles
Interceptor Density	= 640* Interceptors ÷ Area of Analysis	=	☐	Miles of Interceptor Pipe Per Square Mile Land Area
Poverty	________	=	☐	*
Onsite Restrictions	________	=	☐	*
County Growth	________	=	☐	*
Project Cost	________			Thousand $
Federal Funds	________			Thousand $
Index One	________			*
Index Two	________			*
Population Served	________			People

*Unitless

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195

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Exhibit 11-3 (continued)

Residential = (-8692 * ______Vacant Land) + (5347 * ______Land Cost) + (16.42 * ______% Collection Reserve) + (11.24 * ______Manufacturing Density)
- (18804 * ______Nonmobility) + (487.2 * ______Driver Density) + 13466 = ☐ Dwelling Units Per 10,000 Acres*

Commercial = (4302 * ______Sewer Service) - (4515 * ______Vacant Land) - (28.84 * ______Kid Density) + (6249 * ______Interchanges)
- (17.04 * ______Employment Growth) - (2.626 * ______%Collection Reserve) + 5376 = ☐ 1,000 Square Feet Per 10,000 Acres

Office-Professional = (719.5 * ______Railroads) + (33478 * ______Office Zoning) + (36.70 * ______Peak Flow) + (0.3324 * ______House Density)
- (1791 * ______Industrial Zoning) + (572.0 * ______Population Growth) - 459.9 = ☐ 1,000 Square Feet Per 10,000 Acres

Manufacturing = (2591 * ______Railroads) - (3890 * ______Vacant Land) + (2.978 * ______Manufacturing Density) + (85923 * ______Office Zoning)
+ (234.7 * ______Office Vacancy) + (22.7 * ______Airport Distance) + 611.2 = ☐ 1,000 Square Feet Per 10,000 Acres

Wholesale = (166.5 * ______Driver Density) + (86.28 * ______Office Vacancy) + (3.340 * ______Office Employees) + (6043 * ______Employee Ratio)
+ (6949 * ______Unemployment) - (0.1065 * ______Future Income) - 1911 = ☐ 1,000 Square Feet Per 10,000 Acres

Highways = (35.22 * ______Railroads) + (22.98 * ______Land Cost) - (0.1167 ______Government) + (0.5379 * ______Collection Reserve)
+ (25.94 * ______Interceptor Density) + 11.35 = ☐ Miles Per 10,000 Acres

Education = (-3.186 * ______Poverty) + (723.0 * ______Sewer Service) + (437.5 * ______Land Cost) + (95.17 * ______On-Site Restrictions)
- 405.2 * ______County Growth) - (1.415 * ______Sewer Costs) + 428.9 = ☐ 1,000 Square Feet Per 10,000 Acres

Recreation = (270.4 * ______Railroads) + (2.631 * ______Treatment Capacity) + (322.1 * ______County Growth) + (0.9742 * ______Office Employees)
- (3226 * ______Vacant Houses) - (557.8 * ______Industrial Zoning) + 59.52 = ☐ Acres Per 10,000 Acres

Other = (1134 * ______Railroads) - (0.3020 * ______Future Income) - (12175 * ______Vacant Houses) + (649.0 * ______County Growth)
- (245.4 * ______Interchange Density) + (403.8 * ______Residential Zoning) + 3087 = ☐ 1,000 Square Feet Per 10,000 Acres

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Exhibit 11-4

LIST OF INPUT VARIABLES NEEDED TO PREDICT CORE LAND USES IN THE GEMLUP MODEL

Variable	Equation(s)
County Area	Residential
Vacant Developable	Residential, Manufacturing, Commercial
Vacant Undevelopable	Residential, Manufacturing, Commercial
Zoned Office	Manufacturing, Office-Professional
Zoned Industrial	Office-Professional
Limited Acess	Commercial
Population Growth	Office-Professional
Office Vacancy	Manufacturing
Median Price	Residential, Highways
Future Employment	Commercial
Airport Distance	Manufacturing
Track	Manufacturing, Office, Highways
Area of Analysis	All Core Equations
Sewered Land	Commercial
Interceptors	Highways
Collection Capacity	Residential, Commercial, Highways
Peak Flow	Residential, Commercial, Office-Professional, Highways
SMSA Area	Commercial
Tract Area	Residential, Manufacturing, Commercial
Dwelling Units	Commercial, Office-Professional
School Kids	Commercial
Nonmobility	Residential
Median Income	Residential, Highways
Government	Highways
Current Employment	Commercial
Manufacturing Workers	Residential, Manufacturing
Drivers	Residential

estimate, especially projected socioeconomic data. Thus, a simplifying procedure is provided here to reduce user effort to a minimum. This procedure, however, correspondingly reduces the amount of confidence that can be placed in GEMLUP predictions. Using the entire model allows the user to say that there is a 90 percent probability that the predicted land uses will be within ± x percent of their true value. If any shortcut procedure is used, on the other hand, nothing can be said about the confidence level of a prediction. The tradeoff in using a simplified procedure is between time and rigor. Only a user can decide which is more important.

Because many input variables are used in more than one predictive equation, the number of input variables required varies with the combination of equations used. The simplest method uses the following order:

1. residential
2. manufacturing
3. commercial
4. office-professional
5. highways
6. education
7. wholesale
8. other
9. recreation

The first five land uses listed above are considered to be "core" uses that should be predicted for each application. The remaining land uses are considered to be of secondary importance both from an emissions and a theoretical point of view.

Given the extensive data requirements of the non-core land use equations and the relative lack of interest in this impact category in them, it probably is not worth the effort to obtain data needed to use the equations. A user can save a lot of time by just predicting core land uses and "scaling" secondary land uses from them by simple ratios. The ratios are found in the EPA publication referenced above and were developed from raw data obtained during GEMLUP case studies. They are based on mean values for the various land uses.

The quantities of land use predicted by the GEMLUP model to occur within ten years of increases sewage capacity apply to the area of analysis as a whole: there is no spatial resolution in the model's predictions, nor was any ever intended. Spatial impacts are more confidently predicted through first-hand knowledge of a local project's area. Local and regional planners know where things are, and what kind of development if about to go in next. They also know local zoning and where streets and highways will be constructed or improved. This local knowledge is more accurate in internally allocating development than using a numerical technique based on case study information. Reviewers should seek the aid of local or regional planners in allocating and distributing land use quantity impacts.

REGION I Approach--

A six step procedure for this approach, as outlined in Exhibit 11-5, is required.

Step 1: Describe wastewater facility alternatives

In this step you should map on an overlay for the planning area, the proposed facility components noting existing facilities (where appropriate) and proposed new ones. You should also summarize in written form the proposed facilities. At a minimum, the mapping and description should include the following elements (where appropriate) of the strategy:

- Treatment Facility: Location, capacity added, treatment changes, year on-line or staging plan;
- Interceptor(s): location(s), size, year on-line or staging plan;
- Collection Sewers: locations, type (conventional, pressure, vacuum), staging;
- Sewer Service Areas: location, size (in acres);
- On-site System Service Area: location, number of systems.

In addition, you should develop the following information:

- Proposed method of financing
- Components of existing and proposed wastewater flows
    - -residential
    - -commercial/industrial
    - -other
    - -infiltration/inflow
- Assumptions used in estimating existing and projected flows
    - -population projections
    - -industrial/employment projections
    - -water use/wastewater generated
    - -infiltration/inflow
    - -flow reduction
- Regulatory provisions
    - -pre-treatment ordinance
    - -flow reduction requirements
    - -on-site system design and siting requirements

199

Exhibit 11-5

REGION I APPROACH FOR ESTIMATING LAND USE IMPACTS OF WASTEWATER INVESTMENTS*

STEP 1 Describe wastewater facility alternatives

STEP 2 Develop growth potential indicators

STEP 3 Map potential growth and constrained areas

STEP 4 Determine current carrying capacity of developable areas

STEP 5 Determine growth without proposed wastewater facilities

STEP 6 Determine growth with the proposed wastewater facilities

*As modified by USR&E

Step 2: Develop growth potential indicators

The purpose of this step is to assess the growth potential of the planning area relative to neighboring areas. For the purposes of this step, only existing wastewater facilities should be assumed.

The suggested list of growth potential indicators (GPIs) is shown in Exhibit 11-6. This list is suggestive and you may want to modify this list for your own analysis. The purpose of the GPI analysis is to provide information on which determinants -- both supply and demand -- are affecting growth in the planning area.

Most of the information to complete the GPI profile is available from secondary sources from local and regional planning agencies or from interviews with local officials involved in regulating growth.

Step 3: Map potential growth and constrained areas

Based on the descriptive analysis above, this step, again assuming only current wastewater facilities, involves mapping potential areas for growth and areas with potential growth constraints.

Potential growth areas should be delineated as residential, commercial, and industrial and should include land with the following characteristics:

- Slopes ranging from 0 to 10 percent;
- Soil conditions suitable for development as determined by the Soil Conservation Service or similar studies;
- Private ownership;
- Absence of water related constraints such as wetlands, flood plains or a high ground water level;
- Absence, particularly in the case of housing, of nearby adverse influences such as an airport, dump site or heavy industry;
- Reasonable access to existing road system and community facilities.

Areas with potential growth constraints are a subset of the areas mapped above. Included in this category are areas where growth should be constrained, but is not presently constrained by existing land use regulations. Examples include:

- Prime agricultural land.

Exhibit 11-6

GROWTH POTENTIAL INDICATORS

- Housing indicators: Building permit trends: household size; demolitions, rehabilitations, vacancy rates, housing mix.
- Unbuilt lots: How many? Likelihood of Development?
- Recent planning area and regional population trends for last 5-10 years.
- Existing and planned employment centers in the area and region.
- Attitudes of key officials/boards toward growth: Who? What? Factions? Knowledgeable towards means of controlling growth? Congruence of views with citizens.
- Attitudes of citizens toward growth: Issues? Is community divided on growth?
- Zoning and other local land use ordinances: Intended to continue present pattern or to alter it? Enforcement? Major recent changes.
- Regional Transportation Access: Orientation of community; adequacy of major transportation modes.
- Undeveloped land which is both accessible and environmentally suitable: How much is developable? How severe are constraints on marginal land?
- Infrastructure: Existing sewerage, water, street network
- Position in long-term areawide growth pattern: recent trends; growth spurts.

-- Flood plains where development may be allowed if certain building requirements are met.

-- Sites proposed for public facilities by local, regional or state agencies but not as yet acquired.

-- Land adjacent to important wetlands.

-- Aquifer recharge areas.

-- Endangered species habitats.

-- Valuable archaeological resource sites.

In addition to the map, this step should develop summary statistics similar to those shown in Example 11-1. Category A includes all of the land left over after the growth potential areas are mapped. It does not, however, include land that is undevelopable because of on-site wastewater constraints. As shown in the example, this definition of developable land includes 5649 acres. This developable land is then classified into 2 categories: 1) land capable of using conventional on-site wastewater (requiring some type of on-site leaching field); 2) land that requires some type of off-site wastewater disposal. Four categories of land emerge from this analysis:

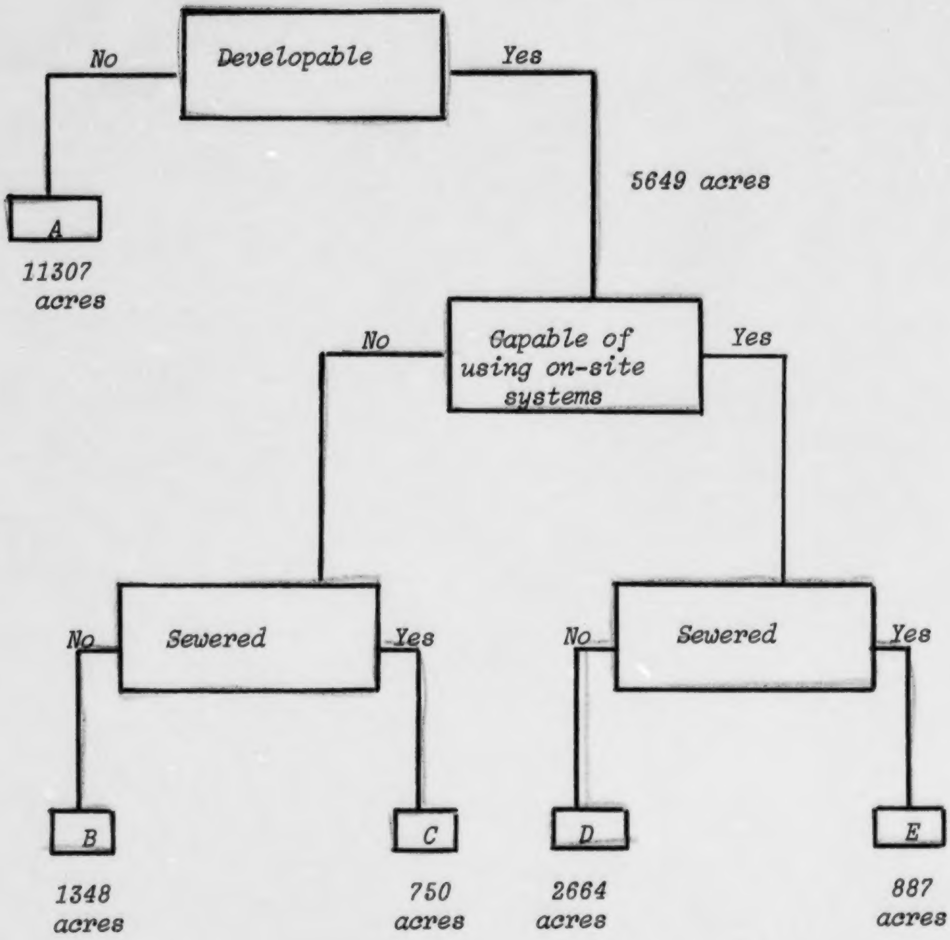
> Category B Land: Land that is developable except for on-site wastewater constraints and therefore requires sewering for development to occur.
>
> Category C Land: Category B type land that has already been sewered.
>
> Category D Land: Land that is developable with on-site wastewater systems but only to a certain density limit dictated by the on-site wastewater constraints.
>
> Category E Land: Land that is developable with on-site systems but has already been sewered.

Step 4: Determine current carrying capacity of developable areas

The current carrying capacity represents the amount of growth that can occur under present land use regulations. It should be expressed as shown below (in acres or units).

Example 11-1

SUMMARY OF SMITHVILLE DEVELOPABLE LAND



Use	Category			
	B	C	D	E
• Residential				
-single-family				
-multi-family				
• Commercial				
• Industrial				

Step 5: Determine growth without proposed wastewater facilities

This step calls for a land use projection under the present growth potential impact indicator assumptions from Step 2. The first task in this step is to determine the appropriate population forecast to use for the planning area for the next 20 years. As outlined in Appendix A of 40 Part 35, you will be required to use the state certified disaggregated population forecasts. If these have not been disaggregated you will need to do this in this step using the growth potential indicator information and the Step 2 analysis as a means for doing this. Population figures may also be available from the areawide water quality or facilities planning effort. In any case, they should be verified by EPA and local planning officials.

You will also have to develop an appropriate employment forecast to use in this Step. Information from the GPI's and Chapter 9 data sources will be useful here -- otherwise you may have to rely on extrapolation of past trends.

At this point you have both supply information (land characteristics and attributes) and demand information (population and employment forecasts). There are several sub-steps necessary to convert the projected population and employment increases into likely growth patterns.

Step 5.1: Allocate population increases into housing categories.

In this Step population increases are allocated into housing categories appropriate to the planning area. Potential categories include single-family, multi-family, and mobile home categories. After examining existing housing category percentages and growth potential indicators, and interviewing local developers, percentage estimates for 10 and 20 year planning periods should be made.

The population increase can then be allocated to the new housing units by use of the following formula:

PI = (x) (a) + (y) (b)

where:

x = Estimated % of single-family units

y = Estimated % of multi-family units

a = Household size for single-family units

b = Household size for multi-family units

Existing household size figures for the planning area can be obtained in the U.S. census which has data at the level. Given recent trends since 1970 in household size which show a decrease in household size across the country, you should consider using smaller household sizes for the planning period. See Example 11-2 for sample calculations.

Step 5.2: Distribute projected growth

Using information from Step 3 and 4, estimate where the new development is likely to go in the planning area. You should divide the growth areas into basic analysis zones and rate them according to their attractiveness for development. Housing units and employment forecasts should then be allocated to the basic analysis zones. Clearly, you will want to perform this analysis with considerable input from the local planning agencies.

Step 5.3: Convert allocations into acreage

This step requires three calculations: 1) Housing units can be converted to acreages using lot size requirements from zoning; 2) employment forecasts can be converted to acreage using employee/acreage ratios of recent industrial and commercial development; 3) roads and other public land associated with the development can be estimated using ratios from existing recent development or from the Costs of Sprawl reference.

Step 6: Determine growth with the proposed wastewater facilities

In the final step, the analysis should be geared towards the following key question. Will the proposed wastewater strategy, as outlined in Step 1, alter the growth projections from Step 5 in terms of:

- the amount of growth?
- the type and density of growth?
- the location of growth?

Example 11-2

PROJECTED SMITHVILLE HOUSING UNIT INCREASE

Projected population increase for 1980-1990 period = 6,200 people

Estimated percentage of housing unit development is expected to be the same as existing breakdown, namely

single-family - 85%
multi-family - 15%

Average household size = 3.92 for single-family
= 2.48 for multi-family

$$\frac{x}{y} = \frac{.85}{.15} \qquad (1)$$

y →

$$x = 5.66y$$

$$6200 = (x)\,(3.92) + y\,(2.48) \qquad (2)$$

$$= (5.66y)\,(3.92) + y\,(2.48)$$

$$= 24.67y$$

$$y = 251$$

Substituting $y = 251$ *into equation 1,* $x = 5.66y$
$x = 1421$ ← 1421

Thus, 1421 single-family and 251 multi-family units are expected to be built.

- the timing and rate of growth?

Hard and fast regressions are not proposed here to answer these questions. Rather, common sense, coordination with local planning officials, and careful analysis of the previous five steps are suggested. Exhibit 11-7 illustrates a decision analysis approach for addressing the growth questions. To help answer the questions in Boxes A, D, G, and J, Exhibit 11-8 provides an initial framework for considering facility investment/growth impact issues.

The estimates in Boxes C, F, I, and L should be made in ranges if necessary or qualified, given the level of discretionary judgement that is required to make the estimates. The estimated impacts should be summarized as suggested in Box M and then compared with the growth projections without the wastewater strategy.

11.5 DATA REQUIREMENTS

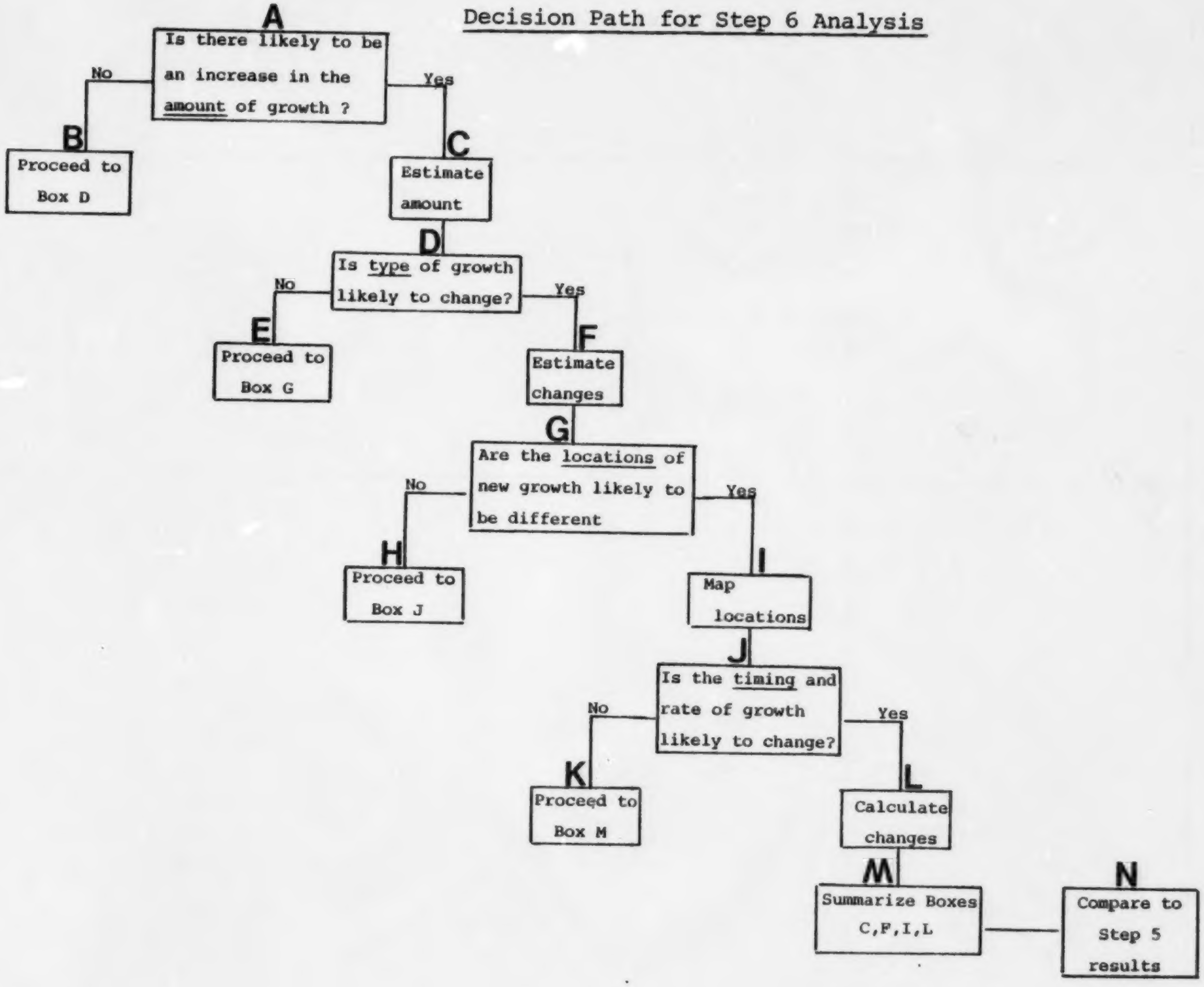
Data requirements for using the GEMLUP model have previously been shown in Exhibit 11-4. Data requirements for using the REGION I approach are shown in Exhibit 11-9.

One of the most important data items is, of course, good existing land use information. If an up-to-date land use map doesn't exist for the planning area, you may have to up-date an older map. Methods for up-dating land use information are shown in Exhibit 11-10.

208

Exhibit 11-7

Decision Path for Step 6 Analysis


A
Is there likely to be an increase in the amount of growth ?
No
Yes
B
Proceed to Box D
C
Estimate amount
D
Is type of growth likely to change?
No
Yes
E
Proceed to Box G
F
Estimate changes
G
Are the locations of new growth likely to be different
No
Yes
H
Proceed to Box J
I
Map locations
J
Is the timing and rate of growth likely to change?
No
Yes
K
Proceed to Box M
L
Calculate changes
M
Summarize Boxes C,F,I,L
N
Compare to Step 5 results

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD: BEGIN SECTIONS HERE
BEGIN LAST LINE OF TEXT
3/8"
FOR TABLES AND ILLUSTRATIONS
PAGE NUMBER
EPA-287 (Cin.)
(4-76)

Exhibit 11-8

WASTEWATER INVESTMENT IMPACTS ON GROWTH

Facility Investment	POTENTIAL GROWTH IMPACT ISSUES[1]			
	Amount	Type	Location	Timing
1.0 Treatment Improvements	x[2]	x[3]		
2.0 Capacity Changes				
2.1 - S.T.P.	x	x		
2.2 - Interceptor	x		x	
2.3 - Collection System	x		x	
2.4 - Combinations of 2.1, 2.2, 2.3	x	x	x	
3.0 Service Area Extensions	x[4]	x[4]	x[4]	
4.0 Staging of 1, 2 and 3.			x	x[5]
5.0 Financing		x[6]		x[6]

Notes

1. Theoretically, each of the impact issues could be related to each type of facility investment listed, depending on the local circumstances. This table reflects the strongest and most obvious correlations.

2. This issue may be relevant in cases where a sewer moratorium has been in effect because of inadequate treatment.

3. Treatment plant improvements, particularly in combination with pre-treatment regulations, may enable certain industrial development to take place.

4. These impacts are most paramount in category B land, unsewered land (see Example 11-1) where wastewater carrying capacity has been a constraint.

5. In service areas provided with excess capacity, land development will likely be accelerated.

6. See discussion in Section 11.1.

Exhibit 11-9

LAND USE DATA SOURCES

Data Item	Data Source	Use
--Existing Land Use	● Local or regional planning agency	Baseline Analysis
--Housing Indicators	● U.S. Census ● Building Inspector	GPIs
--Unbuilt Lots	● Building Inspector	GPIs
--Population Trends	● U.S. Census; Office of State Planning	GPIs
--Employment Centers	● State Department of Employment Security; State Department of Economic Development	GPIs
--Local Attitudes Towards Growth	● Local planning officials	GPIs
--Land Use Regulations	● Local planning officials	GPIs
--Regional Transportation Access	● Regional planning agency; Office of State Planning	GPIs
--Undeveloped Land	● Land use map; Soil Conservation Service maps	GPIs
--Infrastructure	● Local public works officials	GPIs
--Areawide growth patterns	● Regional planning officials	GPIs
--Population --projections	● Office of State Planning; Regional Planning Agency	Growth Impact Analysis
--Proposed Wastewater Facilities Characteristics	● Areawide water quality or facilities planning	Growth Impact Analysis

211

Exhibit 11-10

METHODS FOR UPDATING LAND USE INFORMATION

- Interview the local building inspector to determine location and type of new development

  Technique: Request building inspector to draw boundaries of new development, noting type of new development (residential, commercial, industrial, etc.) density and changes in use.

  Level of Detail: Variable, depending on map scale, accuracy of additions.

  Cost: Minimal; basically includes staff time for interviews, redraw of added developed areas.

- Windshield survey conducted by consultant/planning office staff

  Technique: On-site, field inspection of newly-developed areas. Requires back-up information on recent development in the form of building permits. Can be used to locate newly-developed parcels or to identify new uses. The field sheet used to record this information can be tax assessor maps which will enable acreage to be determined.

  Level of Detail: Good

  Cost: Moderate, basically includes staff time for survey, map corrections at office.

- Recent aerial photos to identify extent of recently developed areas

  Techniques: Purchase of aerial photos from public agency or private mapping company. Developed areas and densities can be delineated from aerials; uses must be checked through other sources (either of the above).

  Level of Detail: Depends on source of aerials. Enlargements can be made if negatives are available.

  Cost: Approximately $5/sheet, plus cost of mapping new areas.

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CHAPTER 12
Other Public Services

12.1 IMPACT DESCRIPTION

Impact Definition

Included in this impact category are public facilities and services -- other than wastewater and recreation facilities -- that may be affected by water quality control strategies. The following impact categories are the types of impact issues that fall within the public services impact area:

- fire protection
- police protection
- solid waste
- water supply
- education
- highways
- storm drainage

It is quite possible that one or more of the above impact categories may not be a relevant impact category for a particular water quality strategy. The above list should only be considered as a potential list of public facility/service impacts. Because of the potential scope represented by this impact category, a screening step is suggested in Section 12.3 below.

Impact Issues

A water quality strategy may impact local public services in many direct ways as well as indirectly through population and economic base changes. The most important impact issues and their relationship to water quality strategies are discussed below.

Direct Impacts --

- Issue PS-1: Public Sewerage Systems/Groundwater Recharge

  In developed areas that rely on septic systems and also obtain their water supply from shallow aquifers beneath the developed areas, the septic systems serve to recharge household water back to the aquifer. The removal of this recharged water by public sewerage may have significant effects on the groundwater levels. Portions of Nassau County, Long Island, for example, that rely on groundwater for public water supply have experienced a drop in the water table due to sewering.[1] A key consideration in this type of effect is the amount of groundwater recharge from the domestic wastewater compared to the amount of groundwater reaching the aquifer from precipitation and surface water sources.

- Issue PS-2: Public Sewerage Systems/Water Consumption Demand

  The issue revolves around whether residents will increase per capita water consumption when changing from on-site disposal systems to sewer systems. While largely a matter of unsubstantiated research, a common engineering practice is to assume that residents with on-site systems tend to restrain water consumption to minimize problems with the on-site systems. When sewers are installed and the on-site restraints are removed, latent demand is supposedly altered and increased consumption pattern is assumed.[2]

  Because little data to date has been collected to accurately verify this phenomena, there is no way of reliably estimating to what extent it occurs and what the range of increase might be. It is reasonable to assume some increases in demand, however, in those areas where on-site systems have frequent problems and where domestic per capita water consumption patterns appear to be lower than other areas with similar homes and income levels.

- Issue PS-3: Land Application, Wastewater Systems; Urban Stormwater Storage Areas/Groundwater Augmentation

  Many areas in the West, particularly California, have successfully demonstrated the case of treated sanitary wastewater or urban stormwater as a means for augmenting municipal ground water supplies. In some cases, this recharge of wastewater or stormwater is used to pre-

216

vent saltwater intrusion into aquifers near coastal areas.

- Issue PS-4: Industrial Wastewater Controls/Water Consumption Demand

A number of industrial wastewater effluent requirements and user charge systems may stimulate industrial water consumption and help to decrease water demand in a community.

- Issue PS-5: Water Conservation Techniques/Water Consumption Demand

The benefits of water conservation to the local water supply system are dependent, of course, on the existing demands on the system as well as the effectiveness of the conservation strategies. Theoretically, in systems where existing consumption demands are straining capacity, reductions in demands may postpone system investments. There may be little impact, however, in systems with substantial capacity. In fact, water utility managers may view water conservation measures as harmful to water revenues. The effectiveness of water conservative strategies is dependent on the amount of water demand desired to be affected. Strategies designed to affect primarily new housing development in relatively stable population areas will affect only a small portion of overall demand.

- Issue PS-6: Public Sewerage System/Disruption of Groundwater Supplies

Sewer pipes in many instances must be laid in stream bed areas. These areas often coincide with ground water aquifers used for public water supply. The trench that these pipes are constructed in, particularly for large interveptors, can under certain groundwater conditions "siphon off" or divert groundwater down the length of the sewer pipe. This may affect the safe yield of public wells located in the aquifer. Areas using pressure sewers or vacuum sewers will be less susceptible to this problem because of the small trench depths.[3] Trenchless sewer construction techniques may also be possible for collector sewers to minimize groundwater disruption.[4]

- Issue PS-7: Urban Stormwater Source Controls/Solid Waste

Litter control and street sweeping controls may coincide with existing sanitation goals. They may require, however, increased level of effort or equipment acquisition.

- Issue PS-8: Residuals Management/Solid Waste

Residuals management strategies may have both adverse and positive effects on local solid waste disposal practices. If, for example, a local landfill is used for sludge disposal, its capacity and operating practices could be affected. On the other hand, the need to manage sewerage-generated sludge may spur new and innovative resource recovery solutions that will obviate the need for local landfills.

- Issue PS-9: Urban Stormwater Flow Attenuation Controls/Storm Drainage

Stormwater detention ponds and site design requirements limiting impervious surfaces will reduce overall community storm drainage requirements. This can result in substantial savings in capital costs. Detention ponds, however, when they become part of the public infrastructure will require maintenance.

- Issue PS-10: Storm or Sanitary Sewers/Traffic Disruption

The construction of sewer lines on existing public streets may be disruptive in heavily travelled areas. This impact may mean increased traffic congestion.

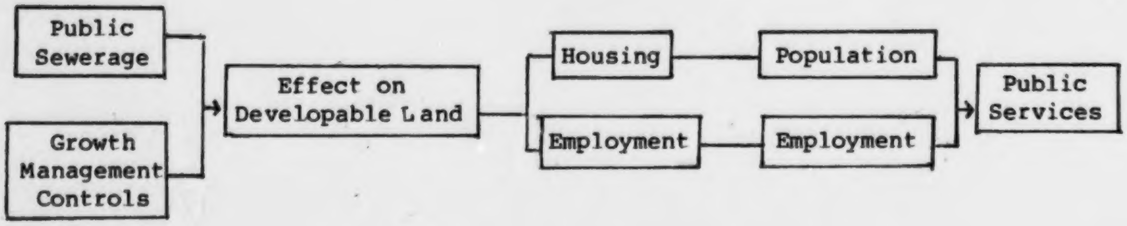
- Issue PS-11: Highway Deicing Controls/Street Maintenance

There are positive impacts associated with the control of deicing compounds. Because sodium chloride -- the deicing agent most often used by communities in snow removal -- can cause severe corrosion damage to metal, its discontinuance can reduce bridge and guardrail replacement and maintenance costs.[5] On the negative side, a reduction or discontinuance in salt use may increase the demand for snow plowing. Also on the negative side and discussed in Chapter 16, Public Health and Safety, is the impact on traffic accidents.

Indirect Impacts --

- Issue PS-12: Growth Management Controls; Public Sewerage/Public Services Demand

Growth management controls and public sewerage potentially may have significant impacts on land use which in turn will stimulate a variety of public services impacts. This impact chain was briefly discussed in Chapter 2 and 11 and is illustrated again below.



As seen in this illustration, the impact chain has several key variables before public services are impacted. Thus, the areawide water quality planner should approach these types of public services impacts carefully. The intervening impact issues are discussed in other sections in this volume.

The most influential factor affecting the nature and magnitude of indirect public services impacts is the existing public services infrastructure itself. The capacity of existing public facilities and services to absorb new demands is a critical factor in determining the nature of infrastructure impacts. For some services, the population changes may be of such an amount and duration that demand may be absorbed with little or no effect in the delivery of services. Other services and facilities may be near their threshold in terms of capacity. The incremental population attributable to water quality controls may be sufficient in some cases to trigger a major change in personnel or capital investment. Water supply is particularly susceptible to small changes in demand triggering major capital investments.

The extreme case concerning the capacity issue is the situation where a particular service or facility does not exist at all. For example, the population increment associated with the water quality strategy may precipitate the need for a new water supply source. The costs associated with starting new facilities and services will generally be higher than in situations where facilities or services are simply being expanded.

In addition to the existing physical characteristics of infrastructure, such as capacity and service area, the existing institutional arrangements will obviously affect the nature and magnitude of infrastructure impacts. Two issues are important: the division of responsibilities between the private and public sector and the division of responsibilities between local governments and other units of government. Where the private sector is providing a particular service, such as solid waste collection, the demands of new population may be absorbed by the private sector without impacting the public sector. The impact on the public sector, however, is also dependent on the contractual relationship between the public and private sector. If, for example, the costs of a private refuse hauler are defrayed by user costs, then new residents will directly bear the additional costs of solid waste collection. On the other hand, if the refuse hauler contracts with a local community for providing services, additional costs may be shared by all residents via the tax mechanism.

The extent to which local services are provided by other-than-local units of government will also affect the distribution of infrastructure impacts. For example, in many areas social services will be provided on a regional basis; some local facilities, such as fire protection or water supply, may be provided at a sub-local basis by a special district.

12.2 IMPACT INDICATORS

Listed in Exhibit 12-1 are potential indicators for one public service issue -- water supply. These indicators should obviously not be considered a universal set appropriate for any impact area. The indicators shown have been structured to cover the following types of measures:

- Demand changes: changes in the number of people using, belonging, or patronizing facilities and services;
- Capacity changes: adjustments or alterations in the supply of facilities and services;
- Performance: measures which indicate adequacy, efficiency, or cost effectiveness of services and facilities relative to demand;
- Distribution: the locations and service area of facilities and services relative to demand.

Based on Exhibit 12-1 similar indicator lists can be developed by the water quality planner for other public service categories.

12.3 PRELIMINARY CONSIDERATIONS

The issue of growth and development impacts associated with water quality strategies, particularly sewer-related projects, is generally one of the most controversial at the local level. This impact category may present something of a resource dilemma, however, for the water quality planner in the impact assessment process. Despite the growing interest in this impact category, there are numerous potential indirect impacts spread across several public service categories. All of these impacts cannot be addressed within the impact assessment process of areawide water quality planning. Because most of the resources for this impact category may be potentially spent on indirect impacts, the screening process should be devoted to population and employment induced public service impacts.

The screening process should explicitly look at both supply and demand issues. The first step involves a determination of the principal factors affecting public service demands attributable to the water quality strategy. These factors are the population estimates and employment estimates from Chapters 11 and 9 respectively. If these population and employment impacts do not occur with a particular strategy, then the impact chain discussed in Section 12.1 is disrupted and public service impacts are not relevant. It is particularly important to express these projected population and employment changes geographically, since many public service impacts are location-sensitive.

In the second step, the water quality planner should look at the supply side of public services in those locations that have been projected in the

Exhibit 12-1

WATER SUPPLY INDICATORS

	Indicator	Impact Issue Appropriateness
WS-1	• Service area (size, location number of public system users, population served)	Impact Issue PS-12
WS-2	• Average daily total daily consumption (million gallons/day)	Impact Issues PS-2, PS-4, PS-5, PS-12.
WS-3	• Consumption pattern by user type (residential, commercial, institutional, industrial)	Impact Issues PS-2, PS-4, PS-5, PS-12.
WS-4	• Maximum day demand; maximum week demand	Impact Issues PS-2, PS-4, PS-5, PS-12.
WS-5	• Location and capacity of water supply source	Impact Issues PS-1, PS-6, PS-12.
WS-6	• Location and capacity of storage facilities	Impact Issue PS-12.
WS-7	• Number of employees	Impact Issue PS-12.
WS-8	• Annual operating costs	Impact Issue PS-12
WS-9	• Annual capital costs	Impact Issue PS-12

221

first step as experiencing population and employment impacts. Because this is a screening type of analysis, this step should rely as much as possible on readily available secondary data. The type of information that is desirable in this screening step is listed below.

- Location: Determine the location of principal facilities and structural components -- for example, fire stations, landfills, municipal wells, schools, etc.

- Service Area: On the same map as above, indicate the existing area serviced by the facilities or agencies. This may not be coincident with political jurisdictions.

- Design Capacity: Determine the design capacity for facilities services. The objective is to determine the extent of slack or available capacity. For some issues, such as water supply and schools, this will be relatively straightforward. For other issues, such as landfill capacity, the judgement of the administrative agency or the owner of the facility will be required. For issues dependent to some or all extent on people resources, ratios of population served to personnel should be used. For example, policeman/population ratios are indications of capacity.

- Present Level of Use: Determine the number of people served by each facility or service or the number of users. Depending on the infrastructure category, there will be a distinction between population served and users. For example, users of a public water supply system are hooked up to a system; users of a solid waste management system are also fairly well defined. For fire or police departments on the other hand, the ratio of personnel to population served is only a crude estimate of measuring demand placed on their services.

The final screening step involves a comparison between the projected demands, i.e., the expected population and employment changes, and the existing and planned capacity of public services. Since this is only a screening step, it is not necessary to convert the expected population and employment changes into actual service demands. Rather, a qualitative judgement should be made of the supply-demand relationship. Of most concern are clear cases of facilities and services at or near capacity. A desirable approach at this point is consulting the appropriate program managers of public services being considered for analysis. This type of coordination -- particularly if potential public service impacts are limited to a few areas -- should not be too burdensome if done by phone. It is useful after the screening step to summarize expected indirect public service impacts by community.

12.4 MEASUREMENT TECHNIQUES

Issue PS-1: Public Sewerage Systems/Groundwater Recharge

The water quality planning agency will require the services of a groundwater hydrologist to accurately determine the effect of removing septic system flows on aquifer yields. It is possible, however, in a crude fashion, as shown below, to show the potential groundwater/water supply impact of sewering previously unsewered areas. This issue, it should be noted, is most important when the proposed sewer outfall will remove the sewered flows downstream of the water supply aquifer.

Step 1: Using U.S.G.S. Hydrologic Atlases, and U.S.G.S. Geological Quadrangle Maps (Surficial Geology), map the aquifer under consideration. Overlay on this map the projected sewer service areas under consideration.

Step 2: Measure the areal extent (acres) of the aquifer.

Step 3: Determine annual rainfall that serves as recharge to the aquifer (average annual rainfall minus runoff and evapotransperation).

Step 4: Determine annual recharge to aquifer: area (acres) x 43560 ft.^2/acre x .75 ft. x 7.5 gal./ft.^3 = # of gallons/year.

Step 5: Determine annual flows removed by sewer system -- septic system flows plus infiltration. This should be available from the water quality strategy or can be calculated using average flows for effected buildings plus standard gallons/linear feet of sewer estimates for infiltration. Total flows removed (gallons/year) = Mgd x 365 days/year.

Step 6: Compare Step 5 results to Step 4. For example, "therefore the water lost to the sewer outfall is an amount equal to approximately 25% of the annual rainfall recharge."

Issue PS-2: Public Sewerage Systems/Water Consumption Demand

As discussed in Section 12.1, this issue is highly speculative. It is only worth pursuing in communities that have water supplies at capacity and that do not have readily available alternatives. A second condition must also be present, namely, existing water consumption in areas with septic systems must be lower than other areas or communities. If these conditions exist, two approaches may be used to estimate water consumption increases attributable to sewering. For the first approach, simply use an assumed per capita demand increase for each household to be sewered. A study in the Brockton, Massachusetts, 208 area (see Reference #2) revealed per capita consumption increases of 5-10 gallons the first year after sewering. The impact attributable to sewering is then calculated by multiplying population sewered for the first time by the per capita increase.

A second approach requires the water quality planner to calculate the per capita increase directly using before and after water consumption data from comparable newly sewered areas. A small sample, say of 30-50 houses, can be used. While water consumption figures are likely to be available by address in most communities, there are three methodological problems to be faced. First, meters may be read on a quarterly or semi-annual basis. At least a year's worth of data should be obtained. Secondly, in order to compute per capita figures, household size will be required. This may be available in a street directory published by a community but it is unlikely that one exists in most communities. The water quality planner will probably be required to use average household size figures from the community. Finally, water consumption varies by income level. In selecting a control neighborhood to determine before and after sewering water consumption figures, the planner should find one that is comparable in type and value of housing to the impact area under consideration for sewering.

Impact Issue PS-3: Groundwater Augmentation

The amount of water supply (in millions of gallons/day) that will be added to the community's supply by land application, urban stormwater, and other techniques can be determined directly from engineering estimates developed for the particular water quality strategy.

Issue PS-4: Industrial Wastewater Controls/Water Consumption Demand

One of the responses for water-using industries to wastewater effluent requirements and to local sewer charges will be a reduction in water use. The type of practices that an industry can take to reduce water include internal recirculation of cooling water to simply installing automatic shutoffs in hoses. In a study of 101 firms in five cities that introduced sewer surcharges it was found that decreased water use was a response in over 55% of the firms.[6] In areawide water quality planning areas with large concentrations of water-using industry, there may be significant water reductions accruing to the area as a result of wastewater control strategies. The measurement of this impact should be done in conjunction with the analysis of private firm costs. (Chapter 8) A suggested approach is the following:

Step 1: Determine industries in the area that will potentially reduce water consumption in response to wastewater controls. The focus should be in water-using industries, i.e., those that require water as part of their industrial process. The water quality planner can set a lower water use boundary to define water-using industries depending on the number of industries in the area. For example, 100,000 gallons/day (.1 mgd) may be used as a lower limit

224

in defining the sample of industries to examine.

If an industrial wastewater survey has been done in the area, water consumption figures are probably available from this source. If one isn't available, the planner should obtain water consumption figures directly from the water department. Industries should be classified by similar type -- laundries, electroplating, jewelry, etc. -- since water using habits are often similar within types of industries.

Step 2: Determine amount of likely water consumption reduction for each firm. If the issue has not been dealt with in an available industrial wastewater survey, there are four approaches for developing an estimate.

- Talk to Firms -- This approach will yield the best results but is the most time consuming if there are a number of plants. It may be necessary to talk to only a few firms within an industry type.
- Examine comparable situations -- A neighboring community may be consulted to determine impacts. It is important, however, to make comparisons only on an industry-by-industry type of basis. Even with this safeguard, local plant characteristics and small differences in controls and charges may make comparison somewhat difficult and unreliable.
- Consult State Water Pollution Control Agency -- State officials may be able to provide estimation based on comparable situations in other communities.
- Consult National Industry Associations -- The major industry groups have national associations that can be consulted for average estimates of water conservation in their industry.

Step 3: Aggregate water consumption reductions by water supply system -- This will yield the total reduction on savings. See Example 12-1.

Issue PS-5: Water Conservation Technique/Water Consumption Demand

In this issue, the planner is concerned with the impact of domestic water conservation techniques on overall water supply demand. The potential savings will depend on how extensive the water conservation program is applied in a community and what type of conservation techniques are applied. (See Appendix A-7.)

Example 12-1

PROJECTED WATER CONSUMPTION REDUCTIONS BY SMITHVILLE INDUSTRIES IN RESPONSE TO WASTEWATER CONTROLS

FIRM	ADDRESS	SIC CODE	PRODUCTS	EXISTING WATER USE (mgd)	PROJECTED 1985 WATER USE (mgd)	SAVINGS (mgd)
1) Agway Inc.	78 Plymouth Street	2040	Animal Feed	.055	.040	.015
2) B'water Foundry Inc.	off High Street	3321	Iron Castings	.210	.185	.025
3) B'water Independent	17 Central Square	2711	Newspaper	.021	.020	.001
4) B'water Shoe Corp.	42 Spring Street	3141	Men's shoes	.005	.004	.001
5) B'water Tool Co., Inc.	30 Sanger Street	3541	Machine Shop	.210	.150	.060
6) Cannon's Eng. Corp.	Elm Street	4950	Petro-Chemical Disposal by Incineration	.325	.250	.075
7) Carlson Machine Co.	275 Elm Street	3599	Machine Shop	.015	.010	.005
8) ConAgg. Industries						
9) Dorr's Print Shop	43 Central Square	2751	Commercial Printing	.005	.004	.001
10) Independent Nail, Inc.	106 Hale Street	3315	Nails	.050	.040	.010
11) George O. Jenkins	120 High Street	3131	Paper Boards	.090	.070	.020
12) George E. Keith Co.	31 Perkins	3141	Men's Shoes	.005	.001	.004
13) McIntire's Dairy, Inc.	792 Plymouth Street	2026	Bottling Milk	.450	.330	.150
14) Henry Perkins Co.	164 Broad Street	3321	Gray Iron Castings	.250	.200	.050
15) Stiles & Hart Brick Co., Inc.	Cook Street	3251	Clay Bricks	.005	.001	.004
16) Super Tire Co.	67 Central Square	3011	Tire & Inner Tubes	.005	.004	.001
17) Union Graphite Specialty Co.	497 Pine Street	3295	Graphite Products	.025	.010	.015

SAVINGS = .397 mgd

Issue PS-6 - Issue PS-11:

In each of these issues, estimation of public service impacts are best obtained from key informants, such as the consulting engineers for a water quality strategy or local officials for the effected service or facility.

Impact Issue PS-12: Population-Induced Public Services Demand

The approach used to actually measure public service impacts resembles that described in the screening analysis, namely;

- Determine demand inputs from population and employment impacts
- Compare demands with existing capacity

Step 1: Determine Public Service Demands -- Using the population and employment impacts from Chapter 11 and 9, the planner should convert these into actual public service demands. Rather than go through each public service impact category, some general techniques are discussed in this step. Considerable material has been published on public service impacts associated with development and the reader is referred to the Real Estate Research Corporation, the Burchell, and Sternlieb references for specific public service impact estimation techniques.

- Historic Indicator Technique -- This technique relies on past experience to determine conversion factors for translating population and employment figures into specific public service demands. The advantage of this approach is that it uses local experience to derive the conversion factors. Public service impacts can be expressed for both residential and non-residential demands. Or a community-wide average can be determined. The approach is illustrated below:

PROJECTING POLICE MANPOWER USING HISTORIC INDICATOR

Present	
Population	100,000
Police Manpower	150
Police Factor/1,000 Population	1.5
Projected	
Population	150,000
Police Manpower	225
Police Factor	1.5

- Service Standard Techniques -- In this approach, manpower ratios are used from references to estimate public service demands. See Exhibit 12-2. It is possible to obtain "ideal service levels" from many sources. In general, you are advised to avoid these often conflicting sources and rely on actual experiences by using the U.S. Census of Governments. This publication contains average ratios for several common municipal functions for municipalities of varying size and geographic location. See Exhibit 12-3 for an example.

In attempting to measure a number of impact indicators for a particular public service impact category, it may be necessary to use both of these conversion techniques. See Example 12-2 which illustrates a variety of solid waste impact indicators. ←

Step 2: Compare Demand Requirements with Capacity -- For some public service impact categories, the water quality planner will be able to make quantitative estimates of impacts on capacity using available published material on services and facilities. See Example 12-4 for examples. In most cases, it will be necessary to discuss the impact of demands on capacity with actual program managers for affected services. These interviews will reveal existing and planned service capacities. From the comparisons of demands with capacities, the planner will be able to estimate incremental public service requirements in an approximate manner.

Step 3: Convert Public Service Requirements to Costs -- The final step is to estimate the costs associated with incremental public service requirements. There are several techniques that can be used:

- Existing Average Costs -- In this technique it is assumed that future costs are equivalent to current per capita costs. This method is used by many communities and is generally a legitimate approach in moderate size communities (between 10,000 and 50,000 people) with moderate population growth. The technique does not consider existing excess or deficient capacity -- thus new population measurements that might require new capital expenditures are not adequately reflected. (See Example 12-3) ←

- Case Study Method -- This technique requires interviews with public service department heads to obtain costing information. It is an appropriate technique in com-

228

Exhibit 12-2

SOLID WASTE SERVICE STANDARDS

		Moderate Urban (30,000 to 100,000)	Small Urban (10,000 to 30,000)	Rural Balance (less than 10,000)
Suburb or Fringe	NA	1 collection vehicle serves about 3,200 dwelling units: 1,000 units = 31% of 1 truck; 1,938 man-hours per year per 1,000 dwelling units	1 collection vehicle serves about 3,100 dwelling units: 1,000 units = 32% of 1 truck; 2,018 man-hours per year per 1,000 dwelling units	1 collection vehicle serves about 3,050 dwelling units: 1,000 units = 33% of 1 truck; 2,040 man-hours per year per 1,000 dwelling units
Indepedent Outlying Community	NA	NA	1 collection vehicle serves about 3,050 dwelling units: 1,000 units = 33% of 1 truck; 2,040 man-hours per year per 1,000 dwelling units	1 collection vehicle serves about 2,900 dwelling units: 1,000 units = 33% of 1 truck; 2,040 man-hours per year per 1,000 dwelling units
Dependent Outlying Community	NA	NA	1 collection vehicle serves about 3,050 dwelling units: 1,000 units = 33% of 1 truck; 2,040 man-hours per year per 1,000 dwelling units	1 collection vehicle serves about 2,900 dwelling units: 1,000 units = 35% of 1 truck; 2,148 man-hours per year per 1,000 dwelling units
Non-urban	NA	NA	NA	1 collection vehicle serves about 1,800 dwelling units: 1,000 units = 55% of 1 truck; 3,475 man-hours per year per 1,000 dwelling units

NA= Not applicable.

Source: Real Estate Research Corporation as cited in Argonne National Laboratory, A Framework for Projecting Employment and Population Changes Accompanying Energy Development, Phase II, August 1976, prepared for the U.S. Energy Research Development Administration, p. 53.

Exhibit 12-3

FULL-TIME PUBLIC EMPLOYEES PER 1,000 POPULATION AND PUPILS FOR MUNICIPAL AND SCHOOL DISTRICT SERVICES, BY MUNICIPAL/SCHOOL DISTRICT SIZE AND REGION OF THE UNITED STATES[1] (NORTH CENTRAL REGION[2])

Municipal Population Size (Number of Residents)	*(Use for Municipal[3] Functions)*	*Less Than 2,500*	*2,500 to 4,999*	*5,000 to 9,999*	*10,000 to 24,999*	*25,000 to 49,999*	*50,000 to 99,999*	*100,000 to 199,999*	*200,000 to 299,999*	*300,000 to 499,999*	*500,000 to 999,999*	*1,000,000 And Over*
MUNICIPAL FUNCTIONS												
GENERAL GOVERNMENT												
Finance Administration		0.22	0.35	0.34	0.30	0.29	0.29	0.34	0.38	0.34	0.42	0.34
General Control		0.83	0.74	0.74	0.57	0.49	0.48	0.54	0.72	0.68	0.70	0.48
PUBLIC SAFETY												
Police		1.16	1.83	1.88	1.72	--	1.72	1.95	2.03	2.35	3.24	4.27
Fire		0.89	0.49	0.61	0.93	1.26	1.32	1.56	1.51	1.62	1.58	1.37
PUBLIC WORKS												
Highways		1.06	1.07	0.98	0.81	0.74	0.74	0.70	0.94	1.25	0.85	0.82
Sewerage		0.01	0.45	0.39	0.40	0.36	0.31	0.43	0.57	0.60	0.41	0.20
Sanitation		0.01	0.33	0.38	0.42	0.55	0.47	0.44	0.82	0.70	0.89	1.11
Water Supply		0.01	0.62	0.63	0.56	0.48	0.50	0.59	1.08	0.77	0.83	0.89
RECREATION AND CULTURE												
Parks and Recreation		0.01	0.22	0.31	0.31	0.44	0.59	0.74	0.82	1.05	0.85	0.48
Libraries		--	0.14	0.17	0.15	0.26	0.22	0.23	0.18	0.34	0.28	0.42
SCHOOL DISTRICT FUNCTION												
Primary and Secondary Schools				81			74			75		
School District Enrollment (Number of Students)	*(Use for Education)[4]*			Less than 1,200			1,200 - 2,999			3,000 and over		

Notes: [1] These figures are read as follows: In a municipality whose population falls between 2,500 and 4,999, there are, on the average, 1.83 full-time employees in the police department per 1,000 population. In a school district whose enrollment (pupils) falls between 1,200 and 2,999, there are, on the average, 74 full-time employees in primary, secondary, and special education services per 1,000 pupils.

[2] Includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin.

[3] Use the multipliers above the dotted line for municipal functions.

[4] Use the multipliers below the dotted line for school district functions.

Source: U.S. Census of Governments, 1972.

2

Example 12-2

SOLID WASTE IMPACTS

7-A Annual Per Capita Solid Waste - Present Annual Waste Unknown

Total Annual Solid Waste Processed	36,500,000 lbs.
Population	20,000
Annual Waste per Capita	1,825 lbs.

7-B Annual Per Capita Solid Waste - Present Annual Waste Unknown

5 lbs./capita/day x 365 days/year = 1,825 lbs./capita/year

7-C Estimating Solid Waste

Annual Waste per capita	1,825 lbs.
Projected Population	30,000
Estimated Waste	54,750,000 lbs. or about 55 million lbs.

7-D Calculating Solid Waste Produced

Type of Waste	Number of Units	Factor	
Residential	2,000	2.4 lbs./capita/day	1,752,000 lbs.
Commercial	100,000	0.1 lb./sq. ft./day	3,650,000 lbs.
City Street	2,000	60.0 lbs./capita/yr.	120,000 lbs.
Sewage Residues	2,000	100.0 lbs./capita/yr.	200,000 lbs.
Industrial Residues	2,000	100.0 lbs./capita/yr.	300,000 lbs.
			6,022,000 lbs. or about 3,000 tons.

7-E Remaining Life of a Landfill in a Stable Community

$$\text{Remaining Life} = \frac{\text{Remaining capacity}}{\text{Total annual waste}}$$

$$= \frac{32{,}000 \text{ tons}}{2{,}650 \text{ tons/yr.}}$$

$$= \text{about 12 years.}$$

7-F Remaining Life of a Landfill Site in a Growing Community

Assuming:

Capacity at present use = 32,000 tons ÷ 2,650 tons/year = 12 years and a 10% annual increase, then

Remaining life = between 9 and 10 years.

3

Example 12-3

CONVERTING PERSONNEL DEMANDS INTO COSTS: TWO APPROACHES

Operating Costs Per Employee Approach	
Projected Police Force	150
Personnel	
Direct (Salaries @ $15,000)	$2,250,000
Indirect (Benefits @ 30% salaries)	$ 750,000
Subtotal	$3,000,000
Nonpersonnel	
Maintenance and Supplies @10% of Personnel Subtotal	$ 300,000
Total	$3,300,000
Per Employee Cost: $3,300,000/150=$22,000	
Operating Costs Per Capita Approach	
Present	
Population	100,000
Police Budget	$2,000,000
Police Budget per Capita	$ 20
Projected	
Population	150,000
Police Budget	$3,300,000
Police Budget per Capita	$ 20

munities with significant excess or deficient service capacity.

- Comparable City Method -- In this method, you consult cities of comparable size to obtain costing information. This allows you to observe economies of scale that exist for certain public services.

7.5 DATA REQUIREMENTS

Data sources are shown in Exhibit 12-4.

7.6 REFERENCES

Citations

1. Kimmel, G.E. and A.W. Harbough, "Analogy-Model Analysis of Hydrologic Effects of Sewerage in Southeast Nassau and Southeast Counties," U.S. Geological Survey, Mineola, New York. Open File Report 75-535, October, 1975.

2. Goldrosen, John, "Water Supply Impact of Sewers" in Alternatives to Sewers Conference Proceedings. Old Colony Planning Council, Brockton, MA, December, 1976.

3. Kriessel, J. F. "Alternatives for Small Wastewater Treatment Systems." U.S. EPA, Technology Transfer, EPA-625/4-77-011, October, 1977.

4. Beetschen, L. J. "Evaluation of Trenchless Sewer Construction at South Bethany, Delaware." U.S. EPA, EPA-600/2-78-022, March, 1978.

5. Abt Associates, Inc. An Economic Analysis of the Environmental Impact of Highway Deicing. Prepared for U.S. EPA, EPA-600/2-76-105, May 1976.

6. Urban Systems Research and Engineering, Inc. "Responses to Local Sewer Charges and Surcharges" Prepared for the Council on Environmental Quality, October, 1979.

Other References:

Schaenman, Philip. Using An Impact Measurement System to Evaluate Land Development. The Urban Institute, 1976.

American Public Works Association. Practices in Detention of Urban Stormwater Runoff. Special Report #43, 1974.

Abt Associates, Inc. An Economic Analysis of the Environmental Impact of Highway Decisions, Prepared for EPA, 1976.

Real Estate Corporation. The Cost of Sprawl, Prepared for CEQ, HUD, EPA, 1974.

Exhibit 12-4

PUBLIC SERVICES DATA SOURCES

Data Item	Data Source	Use
Employment and population impacts	• Employment impact category; population impact category	Issue PS-12
Existing supply for selected public services, location, service area, design capacity, level of use	• Local public service agencies and department	Issue PS-12
Groundwater maps and data	• U.S.G.S.	Issue PS-1
Rainfall data	• U.S. Weather Bureau	Issue PS-1
Septic system and sewer flows	• 208 study	Issue PS-1
Domestic water consumption	• 208 study • Water department	Issues PS-2 and PS-5
Flow augmentation estimates	• 208 study • Consulting engineers	Issue PS-3
Existing industrial water consumption	• Water department • Industrial wastewater survey	Issue PS-4
Projected industrial water consumption	• Industries • National industry associations	Issue PS-4
Existing public service multipliers and costs	• Local public service agencies and departments; other communities; U.S. Census of Governments	Issue PS-12

Sternlieb, George. *Housing Development and Municipal Costs*. Rutgers University, Center for Urban Policy Research, 1973.

Howard County, Maryland. *Howard County Plan*, 1967.

Burchell, Robert W. and Listokin, David. *The Fiscal Impact Guidebook*. Prepared for HUD, March, 1979.

CHAPTER 13

Recreational Opportunities

13.1 IMPACT DESCRIPTION

Impact Definition

Recreational activities are traditionally considered as a socioeconomic issue under the Public Services impact category. They are considered separately here because of the unique impacts that water quality strategies may have on recreational opportunities. Of principal interest in this impact category are the impacts on recreational opportunities that directly occur from the construction of water quality control measures. Of less concern here because of their speculative nature, are the indirect impacts, i.e., increased user demand on recreational facilities, that occur with increased population growth.

Impact Issues

Water quality strategies can impact recreational activities in three ways:

1) Directly, by changing water quality of water-based activities;

2) Directly, by physically altering non-water quality aspects of recreational resources;

3) Indirectly, by stimulating population growth that affects user demand for recreational facilities.

Water Quality Effects--

Typically, recreational activities can be divided into two groups:

water-based and water-enhanced. Examples of the former include swimming or boating, where the water is an integral part of the activity. The latter category comprises hiking, picnicking, etc. where the presence of water may serve to improve the quality of the recreational experience. Water quality improvements are most likely to have the greatest impact on water-based activities, and usually this impact is "stepped." For example, most states have public health codes regulating the maximum turbidity and coliform concentrations permitted in water used for swimming. As long as these standards are met, additional water quality improvement will have only a small impact on recreational opportunity. Conversely, where ambient water quality is improved to the point where swimming can be permitted at a site where it was formerly prohibited, then a large impact on recreational opportunity can be expected. Impacts on fishing opportunities operate the same way. Very polluted waters may harbor no fish, slightly less polluted ones may hold carp, still better water can sustain warm water fish such as bass, and still better water might be suitable for the salmonides such as trout. At each step of change in water quality, the recreational opportunities change, but until another step is reached, water quality improvements are likely to provide only minor additional recreational opportunities.

Water-enhanced activities respond only to the elimination of gross water quality problems, such as strong odors, unnatural colors, or floating wastes although improvements in water clarity (reductions in turbidity) may have some effect.

While these water quality-related effects may be important in your overall socioeconomic assessment of a water quality management strategy, they are not discussed in further detail here. As discussed in Chapter 1, the focal point of this guidebook is on impacts that are likely to vary from one water quality strategy to another. For the purpose of this guidebook, it is assumed that only strategies that meet acceptable water quality goals are considered for impact analysis. (For more analysis of recreation benefits associated with water quality changes see USR&E, 1975.)

Other Direct Effects--

Whenever a water quality control strategy involves the construction of some kind of structure, such as a centralized wastewater treatment facility, the location of the facility relative to recreational activities must be considered in order to avoid displacing or altering the recreational resources. In general, recreational opportunities may be directly affected by water quality strategies in the following ways:

- Physical alteration - by altering or destroying part or all of a resource;
- Physical separation - by isolating or dividing a resource thereby affecting accessibility to the resource;

- Resource enhancement - by increasing the amount of recreational opportunities or increasing the accessibility to resources.

Examples of the first impact issue include wastewater treatment facilities that basically displace areas previously occupied by recreational activities. For example, there is usually intense competition for shoreland uses, particularly between public and private uses. A community seeking a site for a wastewater treatment facility along a river or harbor may opt to displace an existing publicly-owned recreation site rather than displace, for example, tax-paying industrial land.

Physical separation impacts occur in cases where the water quality strategies are land-intensive wastewater treatment facilities, may have this type of impact. Careful siting of water quality control facilities is generally flexible enough to avoid this problem.

While there are definitely many negative recreational impacts potentially associated with water quality strategies, there are certainly many ways in which water quality strategies can enhance recreational opportunities. A concept linking water quality strategies and recreational resource enhancement is multiple use. Essentially, this impact issue reflects a concept that EPA advocates in its facility planning guidelines. Potential recreational enhancement examples include:

- Multiple use of a wastewater treatment facility site as a canoe or boat launching area;
- Multiple use of an interceptor sewer right-of-way for a bike path or pedestrian walkway;
- Multiple use of a land application site for hunting;
- Use of renovated wastewater or sludge for irrigation or fertilizer for golf courses and other recreation areas;
- Multiple use of a stormwater detention lake for water-based and water-enhanced activities;
- Hydrographic modifications, such as water releases from dam impoundments or other low flow augmentation options, may enhance water-based recreation downstream of a dam;
- Multiple use of open space areas created by growth management controls, such as cluster zoning.

It is important to realize that recreational site development might be required to garner any of the recreational benefits discussed above. For example, along a river where water quality is improved enough for swimming, it is necessary to have public access to the river front, a safe swimming beach and possible other facilities to actually permit any swimming at the site. As another example, to use interceptor rights of way for bicycle paths, it will be necessary to pave them, and in some cases to secure the surface rights as well as the underground rights. It is not appropriate to attribute recreational benefit to the water quality management activity unless these necessary ancillary investments will be made.

Indirect Effects--

A water quality strategy can indirectly impact recreational opportunities in two ways: 1) by increasing user demand for a facility; and 2) by altering the ambient environment of a recreational facility. Each of these are discussed below.

As discussed in Chapter 11, water quality strategies that enhance the developability of land, such as wastewater treatment facilities and interceptors, may stimulate population growth in an area. This population increase may, in turn, lead to an increase in demand for recreational services. Increased use may overburden existing capacity of recreational resources thereby crowding problems and affecting the quality of the recreational experience. These "demand-related" effects are comparable to population growth impacts on other public services discussed in Chapter 12. From the point of view of the water quality planner assessing the socioeconomic impacts of a water quality strategy, these demand-related impacts are somewhat speculative to measure. Population impacts, in the first place, are likely to be expressed as a range, thus making correlations between recreation impacts and population difficult. In addition, recreation impacts are also highly dependent on population distribution and population composition changes. It is unlikely that this level of impact information is possible to develop within the socioeconomic assessment. Given these hurdles, demand-related effects, unless population impacts are well-defined, should receive less attention in this impact category than "supply-related" effects.

A water quality strategy will generally alter the immediate sensory environment through visual, noise, or odor impacts. These are discussed in Chapter 15. Depending on the severity of these impacts, nearby uses, such as recreational resources, may also be affected. Poor siting of a wastewater treatment plant may have both visual and odor impacts that can affect nearby land-based or water-based recreation activities. For example, the location of an outfall near a recreation area may not have any actual water quality impacts on the activity, but the mere perception of the outfall's impact may effect the quality of the recreational experience. This perception may substantially reduce use of the recreation area.

13.2 IMPACT INDICATORS

There are several possible supply-related indicators that may be used to express water quality strategy impacts on recreational resources. Initially, you should consider the amount of recreational resources affected, the type of resources affected, and the type of effect. Impact

234

indicators may be developed around these three variables. Examples include:

- number of canoe areas affected;
- number of acres of town park land displaced;
- number of river miles opened up to public access;
- number of days added to the canoe season along the Crooked River (as a result of low flow augmentation);
- number of miles of bike path created.

As discussed above, water quality strategies, through induced population growth or facility displacement, can also affect both the capacity and use of recreational areas. Consequently, it is useful to highlight these issues in an impact indicator.

Both recreation site capacity and use are commonly measured in "user days." A user day is variously defined as use of a site by one person for a period of 8, 12, or 24 hours or simply if he spends any part of a day there so care must be taken to understand the definition employed by a particular source. For "user oriented" sites--facilities like city parks which are close to the visiting public--the eight hour user day is the most applicable unit, but measuring use in terms of "user hours' may be more appropriate in some cases.

The basic impact index is the change in the ratio of use to capacity due to a specific water quality management activity. If U refers to use, C to capacity, the subscript B for "before project" and the subscript A for "after project," then the recreational opportunity index

$$\frac{U_B}{C_B} \Big/ \frac{U_A}{C_A}$$

reflects the impact of the activity. If the index is greater than unity, and all else is equal, then the activity has a positive impact on recreational opportunity. If the index is less than one, then the project reduces the recreational opportunities available to the local population. The difference between the index and one indicates the relative positive or negative effect of the project, and therefore alternative projects can be compared on the basis of their index values.

13.3 PRELIMINARY CONSIDERATIONS

The recreational opportunity index should be constructed for each activity which is affected by the water quality management alternatives. In some cases careful judgments must be made to define a recreational activity. For example, swimming at a pool is actually considered as a different activity than swimming in a natural setting. Where there are wide differences in the quality of the recreational experience--fishing for trout versus fishing for carp, for example--the different recreational activities should be distinguished in the analysis. This is particularly important where water quality management affects a unique facility, site, or activity.

In addition, it will be instructive to analyze separately facilities or activities where average annual use is near capacity. In these cases water quality strategies may have the largest impact on local recreational opportunities.

Also, it is important to differentiate high use activities or facilities from low use ones. In general a project which has a significant impact on a high use facility is more critical than one which has the same impact, measured by the above index, on a low use facility. This effect can be mechanically accounted for by multiplying the index by the current use, so more popular activities will score higher index values than less popular ones. Alternatively, the planner can simply bear in mind the greater significance of changes in the capacity or use in the more popular activities or facilities.

Finally, special attention should be paid to the provision of recreational opportunities for special user groups whose needs are not met by existing facilities. Examples include the elderly or the poor who are unable to access existing sites for physical or economic reasons.

13.4 MEASUREMENT TECHNIQUES

Section 13.2 presents a number of supply-related impact indicators that may be sufficient for your socioeconomic assessment. These indicators are relatively easy to measure. They require:

1) An existing description and mapping of recreational resources in the impact area;

2) A description of the changes in these resources brought about by the water quality strategy, such as areas displaced, capacity increase, changes in accessibility, and changes in the ambient environment; and

3) A comparison between the "before" and "after" situations.

This approach is largely a mapping and desk-top type of analysis, but it will also require key informant interviews with administrators of the recreation areas to more precisely define the nature of the recreational impact.

Recreation Opportunity Index

This index requires the capacity and use of the local recreation system be known both before and after the water quality management activity. The

241

remainder of this section describes methods for estimating these. First, the question of capacity is considered and then estimating use.

Ideally local park or recreation planners will know the design capacity of each of their facilities as well as that of similar private facilities. In many cases, however, this information will not be available, so it will be necessary to estimate capacity by some other method. For facilities which are accessible primarily by car, the size of the parking lot may provide a key to the capacity of the site. In general about 3 visitors can be assumed to arrive in each car. However, the parking lot may exceed the reasonable use capacity of the facility, or there may be substantial informal parking available. Then it is necessary to compute capacity as a function of the physical attributes of the facility. Total capacity in the local area for a given activity equals the sum of the capacity of each of the facilities for that activity.

The "after water quality management" local recreation capacity equals the "before" capacity plus or minus the changes associated with the water quality management activity. Once the planner has described exactly how the water quality management activity alters the local recreation system, the change in recreation capacity should be estimated. For example, suppose that along some stretch of river a water quality control strategy reduces turbidity and coliform counts to fall within the state's public health standards for swimming water. Then the additional recreational capacity equals the feet of river front which are accessible for public use and have a suitable beach for swimming.

Total recreational use in the local area can be estimated in several ways. Again ideally the local parks and recreation department will have accurate and current data for the use of nearby public and private facilities. Sometimes data such as these are collected by regional or state authorities. Alternatively, it is possible to estimate the total use in the area from the area's population. The population in the user area is multiplied by a population use ratio developed from national surveys. The Bureau of Outdoor Recreation periodically conducts these surveys (the last one published covers 1975 data) and publishes the data for different regions of the country. Typical ratios are shown in the following table:

POPULATION-USE RATIOS FOR SELECTED ACTIVITIES:
NORTHEAST REGION

Activity	User-day/person over 14 years of age
Total Outdoor Recreation	69.0
Swimming	11.4
Boating	2.4
Fishing	2.3
Walking for pleasure/nature walks	14.9
Bicycling	7.9
Birdwatching/photography	3.6
Outdoor games or sports	14.2
Picnicking	3.5
Horseback riding	.7
Camping	1.9

The most difficult part of the methodology is to estimate the after water quality management recreational use. In general there are two separate sources of changes in recreational use, and there are different methods for estimating the magnitude of each effect. First, the population increases associated with development induced by the water quality management activities can be treated using the population ratio methods discussed above. That is, additional use of the local recreational sites equals the new population multiplied by the appropriate factor shown above.

Second, where water quality management changes the activities available at a site, or permits the opening of a new recreational facility, then recreational use can be expected to change. But estimating the magnitude of this change is quite difficult. One approach is to argue that observed recreational use is independent of the supply, so that opening a new site will only lead to less congestion at the old site but no new use. Another approach is to argue that recreational sites, like highways, will eventually be used to capacity, so the additional use "caused" by the new site equals the capacity. An intermediate approach is to argue that use at a new site will be equal to the use at a similar site which is already in existence. Care must be taken in comparing sites in using this approach. Site characteristics which must be considered include: accessiblity, cost, and quality. Differences in sites in these respects can be expected to lead to differences in use.

Accessibility refers to the amount of time and discomfort involved in reaching a site. In general, all else being equal, a less accessible site will attract less use. A twofold difference in the time required to reach a site will imply a difference of from one-half to one-fifth in use.

Costs of using a site, in terms of travel cost, entrance fees and parking charges, all tend to discourage use of a site, and differences in the cost of use should be considered in the similar site comparison. The empirical research on this question suggests that a 1% difference in cost will lead to a 1% to 3% difference in use. This fact can be used to establish entrance fees on popular sites to divert use from overused areas to less well-known ones.

Quality factors are very difficult to compare. For example, some users find crowds at a beach annoying, while others desire crowds as an integral part of the recreation experience. The setting of the site, its maintenance and facility design are all likely to affect use, but the magnitude of the affect is unclear. Appropriate adjustments are best left to local considerations supplied by local recreation and park administrators.

13.5 DATA REQUIREMENTS

Suggested data sources are listed in Exhibit 13-1.

13.6 REFERENCES

Urban Systems Research and Engineering, Inc., The Recreation Benefits of Water Quality Enhancement: Analysis of Day Trips in an Urban Setting, Prepared for EPA, EPA--600/5-78-101, 1978.

Clawson, Marion and Knetsch, Jack C. Economics of Outdoor Recreation, Published for Resources for the Future, Inc., by John Hopkins University Press, Baltimore, 1966.

Davidson, P., Adams, F.G., and Seneca, J.J., "The Social Value of Water Recreational Facilities Resulting from an Improvement in Water Quality" in A.V. Knesse and S.C. Smith (ed.) Water Research, John Hopkins University Press, 1966.

Fogg, George, Park Planning Guidelines, National Recreation and Park Association, December, 1974.

U.S. Department of the Interior, Bureau of Outdoor Recreation, 1975 Summary of Outdoor Recreation Activities, 1977.

Exhibit 13-1

RECREATIONAL OPPORTUNITIES DATA SOURCES

Data Item	Data Source	Use
- Inventory of public and private recreation sites	● Local parks and recreation departments ● State recreation department ● Commercial recreation atlases	Supply analysis
- Site's physical characteristics, including carrying capacity	● Field survey ● Above sources	Supply analysis
- Recreational use	● Above sources	Demand analysis
- Potential user population	● 208 Study ● Regional planning agency	Demand analysis
- Population-use ratios	● BOR survey	Demand analysis

CHAPTER 14

Historic Resources[1]

14.1 IMPACT DESCRIPTION

Impact Definition

Historic and cultural resources are limited and nonrenewable assets, such as districts, buildings, sites, structures, and objects, having significant associations with historic, architectural, archeological, or cultural events, persons, groups, and social or artistic movements. If these resources are particularly unique, they may be eligible for inclusion in the National Register of Historic Places. This is a register of districts, sites, buildings, structures and objects significant in American history, architecture, archeology and culture. The National Register is maintained by the Secretary of the Interior. In order to be eligible for inclusion in the National Register, such resources must:

- be associated with events that have made a significant contribution to broad patterns of our history; or
- be associated with the lives of persons significant in the past; or
- embody distinctive characteristics of a type, period or method of construction; represent the work of a master; possess high artistic values; or represent a significant and distinguishable entity whose individual components may lack distinction; or
- have yielded or may be likely to yield information important in pre-history or history.

In addition to the resources in or eligible for the National Register, historic and cultural resources may include those resources listed in Exhibit 14-1.

Justification for preservation of areas of historic, architectural, archeological, or cultural values incorporates arguments based on historical, social, psychological, educational, and economic factors. Among these factors, six rationale for preservation of manmade artifacts and districts have been advanced in a recent EPA report:

"First, it is argued that an environment with cultural and historical continuity is socially beneficial. A community ought to preserve some parts of its past in order to recognize what it is, how it became what it is, and how it differs from others.

Second, daily life is enriched through preservation of historic sites and buildings. This assumes that temporal variety and architectural diversity in the environment are more desirable than homogeneity and monotony and that preservation of historic architecture enriches the environment.

Third, preserving the visual reminders of a community's past allows people to relate to events, ideas, movements, and persons believed to be important to understand and honor. Also, the presence of the physical past helps to fulfill society's expectations for the environment and promotes well-being.

Fourth, it is argued that notable architecture and landscapes should be preserved on the basis of their intrinsic value as art.

Fifth, in some cases, preservation of historic areas stablizes or increases the economic base of their locales. This is the prevailing justification for the approval of historic district ordinances by State Supreme Courts.

Lastly, socially oriented preservation programs can be important for maintaining socioeconomic characteristics of neighborhoods. In few cases where preservation programs are so directed, they may complement traditional urban renewal programs, with the advantage that displacement of residents is not necessarily required."[2]

Impact Issues

Because there is a fixed supply of historic and cultural resources, any loss or impairment will result in an irreversible loss for future generations. Wherever a water quality control strategy involves, in particular, the construction of some kind of structure, such as a centralized wastewater treatment facility, or excavation, say, for installation of sewer lines, the location of those activities relative to historic and cultural resources must be considered, in order to avoid displacing or altering those resources.

Exhibit 14-1

HISTORIC AND CULTURAL RESOURCES OF INTEREST IN SOCIOECONOMIC IMPACT ASSESSMENT

HISTORIC RESOURCES

- Sites and structures connected with events significant in the cultural, political, economic, military, or social history or the locality, the state, or the nation;
- homes or places where significant activities took place or notable personages of the locality, state, or nation;
- sites or groups of structures representative of a period in the historic development of the locality, state, or nation, such as seaports, agricultural settlements, major crossroads, rivers, and canals;
- Indian remains or burial grounds; and
- cemeteries, when used over a long period of time or for burial of important historic personages.

ARCHITECTURAL RESOURCES

- Individual structures of all kinds and uses representative of the architectural development of the United States, including structures of national, state, and local significance;
- works of architects and/or builders who have made significant contributions to the history of American architecture, engineering, or building technology, or important works of locally important architects and builders;
- unique or indigenous building forms, such as wind or water powered grist or saw mills, traditional rural building types such as bank barns, round barns, log structures, and architectural curiousities;
- military fortifications or other structures where visible remains exist;
- building groupings at street or block-front scale where the significance and importance of individual structures is increased because of their relationship to the grouping, or a row of other significant structures which may or may not be of similar period or design style;
- districts or significant concentrations of quality buildings or sites, often made up of individual landmark structures supported by a larger number of structures having lesser importance;
- special character areas, differing from historic districts in that their significance may be the result of a concentration of activities rather than (or in addition to) the presence of historic buildings, structures, or sites (e.g., Bourbon Street, New Orleans; Fishermen's Wharf, San Francisco, etc.); and
- fixed works of art, commemorative sculpture, wall murals, graphics, funereal sculpture, and items of distinctive street furniture, such as clocks, lamp posts, etc.

CULTURAL RESOURCES

Cultural resources include libraries, schools, museums, art galleries, theaters, fraternal organization meeting places, churches, and other places of worship.

ARCHAEOLOGICAL RESOURCES

Archeological resources provide valuable information about the prehistoric past, including insight into human life and cultural activities. Such resources may include prehistoric villages and dwellings, objects used in everyday life activities, and the remains of plants and bones of animals.

In general, historic and cultural resources may be affected by water quality controls in the following ways:

- Physical alteration -- alteration or destruction of part or all of a resource;
- Physical separation -- isolation or division of a resource;
- Neglect of a resource leading to deterioration of the property;
- Disruption of ambient environment -- possibly leading to accelerated deterioration of resources; and
- Increased usage due to induced development.

Physical alteration effects are perhaps the most common potential impacts associated with water quality controls. Projects typically having significant potential for physically altering historical resources include any project involving construction. Sewage treatment plants, stormwater controls, storm and sanitary sewer lines, and hydrographic modifications -- all are prime examples. The direct effects of these construction projects may be experienced by historic resources even a distance away from the construction. The excavation of sewer lines may not only affect subsurface archeological resources, but may also cause damage to nearby historic structures because of subsidence. Land intensive projects, such as large sewage treatment plants, or residuals management projects, are most likely to cause physical separation effects. Neglect impacts are often experienced in situations where it is necessary to incorporate historic resources into the property for the water quality control.

Many historic and cultural resources will be indirectly affected by water quality controls. The most common intermediary impact category is the sensory one. Noise, visual, and odor effects related to a water quality control can all be particularly disruptive to historic resources or their settings. Finally, the other common impact on historic resources resulting from water quality control is excessive use. This problem generally is an indirect effect of direct land use/population impacts.

These impacts are summarized in Exhibit 14-2.

14.2 IMPACT INDICATORS

The selection of appropriate impact indicators to measure the historic and cultural impacts discussed above is not entirely straightforward. The historic and cultural resources impact category involves qualitative as well as quantitative impact measurement. Clearly, in this impact category, it is necessary to consider not only the amount of resources affected, but the type and importance as well. This distinction is legally recognized by the elaborate legislative and regulatory requirements for the consideration of historic resources embodied, for example, in the National Historic Preser-

Exhibit 14-2

HISTORIC AND CULTURAL RESOURCES IMPACT ISSUES

DIRECT IMPACTS	IMPACT STIMULANT
• Physical alteration of resources	Construction-related controls, such as sewage treatment plants, storm water controls, storm and sanitary sewer lines, and hydrographic modifications.
• Physical separation of resources	Land-intensive projects, such as sewage treatment plants and residual management controls.
• Neglect of resources	Projects incorporating resources on control strategy property.

INDIRECT IMPACTS	IMPACT STIMULANT
• Disruption of ambient environment	Sensory-related effects
• Increased usage of resource	Land use and population effects

vation Act of 1966 (PL 89-665) discussed in the next section. Thus, those resources on or eligible for the National Register are required by law to receive special emphasis in impact assessment.

Impact indicators for historic and cultural resources, then, may be structured in various combinations around four variables:

- amount of resources affected;
- type of resources affected;
- importance of resources affected; and
- type of effect.

Example generic indicators include the following:

- number of National Register sites affected;
- number of Indian burial grounds that will be displaced;
- number of Colonial-period churches, late 19th century canals, etc., affected.

As seen from the above, the selection of indicators in this impact category will depend on the presence of local and national historic and cultural resources.

14.3 PRELIMINARY CONSIDERATIONS

Review of Pertinent Legislation and Regulations

Unlike many of the other impact categories discussed in the guidebook, the historic and cultural resources impact category requires those agencies involved in a federally-funded project to comply with a complicated set of regulatory procedures. Because the level of detail in areawide planning may preclude the necessity for doing an elaborate assessment of historic and cultural resources, the process for complying with the Federal regulations will occur during the design stage. In any case, the areawide water quality planner should be aware of the National Register program discussed below.

A national policy of historic preservation was first authorized by the Historic Sites Act of 1935. The Act called for a survey of potential sites of exceptional historic value by the Department of Interior. The National Historic Act of 1966 reaffirmed this mandate and set out in detail the basic Federal policy for historic preservation. The Act set forth the following:

- Directed the National Register of Historic Places be expanded to include the properties of state and local as well as national significance;

- Established the Advisory Council on Historic Preservation (ACHP);
- Required the Council to comment on any undertaking which involves the Federal government and might affect a National Register property.

Executive Order #11593 of 1971 enlarged the role of the council in Federal actions by requiring it to review and comment on undertakings affecting properties eligible for nomination to the National Register as well as those already listed in the National Register.

Historic resources must also be considered in the assessment plans required by the National Environmental Policy Act of 1969 (NEPA). In order to meet the requirements of NEPA and the National Register regulations, the ACHP issued "Procedures for Protection of Historic and Cultural Properties," 36 CFR Part 800, also known as Part 800. These requirements are referenced below in the scoping analysis. The implications of the National Register regulations are that the obligations of a Federal agency to assure historic resource impacts pursuant to the National Historic Preservation Act and Executive Order 11593 are independent from NEPA and must be complied with even when an environmental impact statement is not required.

The National Historic Preservation Act is implemented in cooperation with the State Historic Preservation Officers (SHPO), who are responsible for administering the National Register program within their jurisdiction. Nominations for the National Register are reviewed by the SHPO and forwarded to the Department of Interior.

The criteria outlined in Section 14.1 are used to determine if a resource is eligible for the Register. Ordinarily cemetaries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years will not be considered eligible for the National Register. However, such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

- a religious property deriving primary significance from architectural or artistic distinction or historical importance; or
- a building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

- a birthplace or grave of an historical figure of outstanding importance if there is no other appropriate site or building directly associated with his or her productive life; or

- a cemetary which derives its primary significance from graves of persons of transcendant importance, from age, from distinctive design features, or from association with historic events; or

- a reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

- a property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own historical significance; or

- a property achieving significance within the past 50 years if it is of exceptional importance.[3]

Scoping Analysis

The scoping analysis for this impact category may involve considerable time to conduct because of the likely lack of information on historic resources in the planning area. This problem is compounded in areawide water quality planning by the fact that many water quality strategies will be defined in general terms without any or very little site specific information. It is very difficult to determine the likelihood of historic impacts without some specific data on the water quality control strategy and historic sites and areas.

There are basically four types of situations that may confront the planner in an attempt to determine direct historic impacts in the scoping analysis. These are shown below:

Historic Resources Data	Water Quality Strategy Type	
	Site Specific	Non-Site Specific
Data available	Case A	Case B
No data available	Case C	Case D

At first glance, it would seem appropriate that Case A situations should receive the most attention in the scoping analysis and Case D situations the least. The lack of existing information on historic resources in the planning area is not acceptable, however, as a reason for discarding Case C and Case D situations. Unlike other impact categories, the scoping analysis for historic resources has to be closely linked with regulatory procedures -- in this case, the review procedures set forth under the 36 CFR Part 800 guidelines.

As described by Part 800, "At the earliest stage of planning, including comprehensive or area-wide planning in which provision may be made for an undertaking..., the Agency Official shall take the following steps to comply with the requirements of Section 106 of the National Historic Preservation Act and...of Executive Order 11593:"

- Identification of resources
- Determination of effect
- Effect established
- Finding of no adverse effect
- Finding of adverse effect
- Preliminary case report

If an adverse effect is determined, a lengthy "consultation and mitigation" process would then occur.

One of the consequences of this process for water quality planning is that the planning agency may be required by the SHPO to contract for additional professional surveys to identify resources. This is not likely in Case D situations, but may be required in Case C situations depending on how close to implementation a project is, and whether the SHPO believes important historic resources may exist in the proposed project area. It may also be necessary to determine which resources not presently on the National Register may in fact be eligible for the Register.

Because of the discretionary powers of the respective SHPOs in determining the impacts of water quality strategies on historic resources, it is not possible to prescribe here a definitive scoping analysis or measurement approach. The approach suggested below assumes close coordination with the State Historic Preservation Officer.

Step 1: Examines critical characteristics of water quality alternatives

The general characteristics of a water quality alternative will have been described as part of the Impact Identification stage. The first step in the scoping analysis is to examine the site specific aspects of the alternatives. Alternatives that cannot be described in specific location terms should probably not be considered for historic impacts -- that is, Case B and Case D situations. If at a later time, more specific information is developed for these alternatives, their impact on historic resources can occur. Without location information, historic impact assessment is simply too conjectural.

For those alternatives with location information, their characteristics of most concern to the historic impact category are the following:

- Physical -- size, height, form, lighting
- Land -- amount and location
- Construction activities -- nuisance aspects, alternatives, excavations
- Operating aspects -- nuisance aspects
- Areas expected to be impacted by growth associated with the alternative

The location of the alternatives should be mapped then as precisely as possible.

Step 2: Identify Historic Resources

The agency should contact the SHPO to determine all known cultural and historic resources that have ever been identified in the vicinity of the proposed alternatives and in the expected growth areas. A trial and error approach may be required since in Step 3 the goal is to define more closely the probably impact areas. In this step, the planning agency will want to avoid excessive data collection. Thus, a preliminary area of impact in which to identify historic resources should be determined based on Step 1 analysis. The addresses and phone numbers of the respective SHPOs is included in Appendix D. This identification should include National Register properties and those properties eligible, identified by the SHPO that are eligible for the Register. If the SHPO feels that the existing information on historic resources is moderate in the project area, the SHPO may require that a detailed survey take place simultaneously later in the more detailed design stages of a project. the assessment of historic impacts during the areawide planning stage then should be considered only to be preliminary. The agency should also request local project area sources of historic resources information. These local sources, such as historical and architectural societies, may have also identified sites that, if brought to the attention of the SHPO, might be considered for nomination to the National Register. National Register nominations must be approved by Heritage, Conservation and Recreation Services in the Department of Interior, after they have been reviewed by SHPOs. Procedures vary, however, from state to state on writing nominations. Many state SHPOs depend on local communities to nominate properties. In other states, like Rhode Island, all nominations are written by the state preservation agency. In any case, it is unlikely that the water quality management agency will be directly involved in the writing of nominations.

Finally, the water quality agency should map the resources that have been identified, noting where possible the difference in significance among the resources. These resources should be mapped on the same map with the water quality alternatives.

Step 3: Identify Probable Impact Areas

Based on the composite map developed in Steps 1 and 2, it should be possible to identify areas where historic impacts are likely to occur and therefore require formal assessment. Given the alternatives, their characteristics of interest to historic resources, and the location of historic resources, the water quality management agency will be able to identify the historic areas that are likely to be affected.

In general, the closer the project to the resource, the more likely that there will be an impact. The impact-distance relationship, however, varies by the characteristic(s) of the project and by the historic resource being affected. For example, a sewer line excavation in a street is more apt to affect an historic house that abuts the street than it will an historic farm area. Projects with nuisance characteristics -- sensory, noise, or odor -- will tend to affect historic resources at a greater distance than projects involving only construction disruptions.

At this stage, it is not necessary to make a resource-by-resource determination -- defining areas impacted is sufficient. If there is time and there are resources available, the scoping analysis can be sharpened considerably by visiting the historic resource sites.

14.4 MEASUREMENT TECHNIQUES

The types of issues to be determined in the assessment of historic resource impacts revolve around the four types of effects mentioned in Section 14.2, namely, the amount of resource affected, type of resource affected; importance of resources affected, and type of effect. Two approaches are outlined to reflect the Part 800 regulatory guidelines for National Register sites.

Method 1: National Register Property Approach

Under this method the water quality planning agency relies exclusively on the SHPO staff to confirm the historic effects and the severity of the effects for each National Register and Register eligible property. The water quality management agency should present the information on the projects and the affected resources for the SHPO's review. This review will determine which resources are affected and the adversity of effect. The principal criteria used to determine adverse effects are those listed in Section 14.1 under Impact Issues, namely, physical alteration, neglect, disruption of ambient environment, and increased usage due to induced development. In order to expedite the SHPO review process, the water quality management agency should present information on each impacted resource. A sample worksheet is shown in Example 14-1. The SHPO may also use site visits as part of the assessment process for selected properties to supplement information provided by the agency.

Method 2: Non-National Register Property Approach

There are many states and many areas within states in which Nation Register and Register-eligible properties have not been identified. If many locally important resources have been identified in the Scoping Analysis, the agency will be required to work with local agencies to jointly assess historic impact. The same approach used with the SHPO is suggested:

- Complete Historic Resources Impact Worksheets
- Apply Adverse Effect Criteria
- Summarize Amount, Type and Importance of Resource Affected

There are two issues associated with Method #2. First of all, there may be many resources in the impact areas that have "local importance." The agency should work closely with the local historical agencies to ensure that time is spent on examining impacts on the most important resource. Secondly, there is the question of expertise. The agency may require outside local expertise, if it is not available in the local historical society. Local universities are a possible source. Alternatively, it may be possible to obtain some staff assistance from the SHPO office.

14.5 DATA REQUIREMENTS

State Historic Preservation Officers are a relatively recent phenomenon and support staff size varies considerably from state to state. Thus, it is not possible to rely solely on the SHPO for local historic resource identification. If the impact analysis deals with non-National Register properties, the agency will have to tap several possible secondary sources for data. Potential sources are listed in Exhibit 14-3.

14.6 REFERENCES

Citations

1. Much of the material for the chapter is drawn from Abt Associates. Manual for Evaluating Secondary Impacts of Wastewater Treatment Facilities. U.S. Environmental Protection Agency, Washington, D.C., January, 1978, Chapter 5.

Example 14-1

HISTORIC RESOURCES IMPACT WORKSHEET

DESCRIPTION OF HISTORIC RESOURCE

Name:	Nipmuc Indian Burial Ground
Location (attach map):	Water Street, Pembroke
Original Use:	Indian burial ground
Present Use:	Vacant wooded area
Historic Significance:	This is one of three known burial grounds of the Nipmuc tribe in Southeastern Massachusetts. Probably dates back to early 17th century.
References:	Wilson, C. Massachusetts Archaeology. Plymouth Press, 1923.

WATER QUALITY PROJECT DESCRIPTION

Name:	North River Interceptor and Pumping Station
Location:	(Show in attached map)
Distance from Resources:	Goes through southern portion of burial ground

PROJECT CHARACTERISTICS AFFECTING RESOURCE	IMPACT ISSUES
A. Excavation during construction for interceptor trench	A. Physical alteration of resource
B. Access roads	B. Increased use and disruption of resource
C. Pump station aesthetics	C. Disruption of ambient environment

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Example 14-1 (continued)

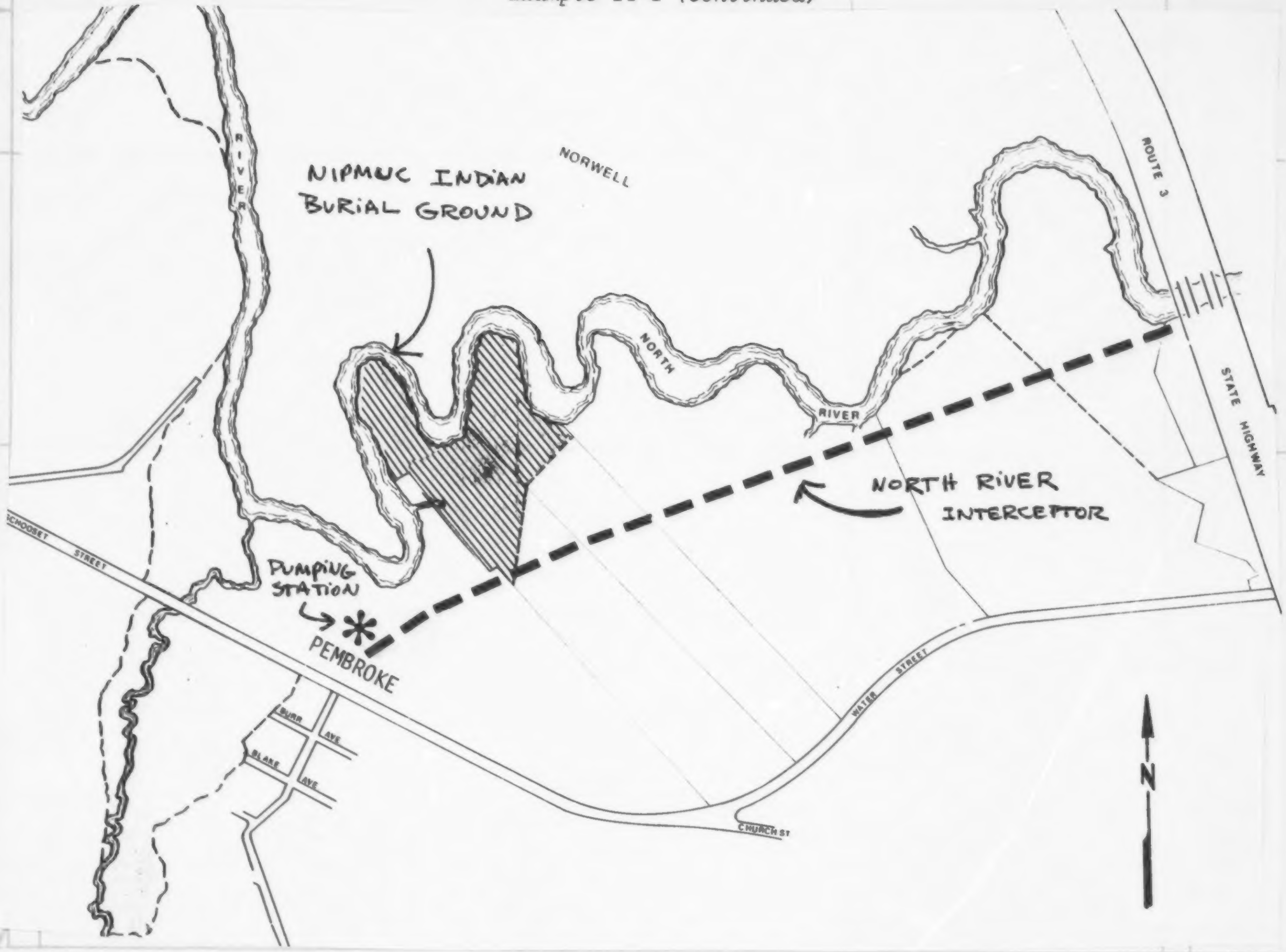

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EXHIBIT 14-3

HISTORIC RESOURCES DATA SOURCES

Data Item	Data Source	Use
National Register Properties	State Historic Preservation Officer (SHPO) National Register of Historic Places, published annually in February in Federal Register	Assessment Method 1; Scoping Analysis
National Register eligible properties	State Historic Preservation Officer (SHPO)	Same as Above
Locally significant resources	Catalogs of the Historic American Buildings Survey (HABS) and publications of the Historic American Engineering Record (HAER) Records of state and local historical societies Local histories and newspaper magazine articles Records, if available, of the state or local chapter of the Society for Industrial Archaeology Records of local chapters of the American Institute of Architects	Assessment Method 2; Scoping Analysis

260

2. Kaiser, Edward J., et al. *Promoting Environmental Quality Through Urban Planning and Controls.* U.S. Environmental Protection Agency, February, 1974.

3. 36 CFR Part 800.10.

Other References

- Skidmore, Owings & Merrill. *Environmental Assessment Notebook Series: Notebook 4--Physical Impacts*. Prepared for the U.S. Department of Transportation under Contract No. DOT-OS-40175. 1975.

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- National Park Service, U.S. Department of the Interior. *Guidelines for Local Surveys: A Basis for Preservation Planning*. Office of Archaeological and Historic Preservation, Draft Report, 1976.

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- Schaenman, Phillip S., and Thomas Muller. *Measuring Impacts of Land Development*. Urban Institute. November 1974.

- U.S. Department of the Interior. *National Register of Historic Places.* Listed annually in February issue of *Federal Register*; updated monthly in the *Federal Register*.

CHAPTER 15
Sensory

The assessment of sensory impacts from water quality strategies relies heavily on subjective judgements. Many people perceive their surroundings, for example, in terms like "beautiful," "ugly," or "noxious." For the purpose of impact assessment, however, it is difficult to obtain agreement among observers as to precise definitions of these terms. This section will provide the water quality management agency with some guidelines in considering the subjective sensory impact category.

The senses that play the largest roles in our perception of the world are sight, sound, and smell. The remaining senses, touch and taste, play a less important role in our experience with a larger environment. Thus, this section will address three types of sensory impacts of concern in water quality strategies: visual quality, noise, and odors.

15.1 VISUAL QUALITY

IMPACT DESCRIPTION

Impact Definition

This impact category focuses on the aesthetic interrelationships between manmade and natural features of an area. The purpose of this category is not to judge water control strategies in terms of their potential contribution to a "beautiful" or "harmonious" environment -- a usual concern of aesthetic evaluations. Rather, the assessment process outlined here attempts to determine whether a particular strategy will impede one's ability to "sense" the context in which the strategy is implemented or whether the project will alter the visual character of its landscape.

Impact Issues

The implementation of a particular water quality management strategy can have a variety of effects on the visual environment. Structural controls will by definition cause some changes in an area's landscape during the construction period. The extent of long-term impacts of structural controls will depend on the scale of the "structure" in relation to its surroundings: a large treatment plant in an industrial area may not present a major change in the area's landscape. However, the location of a large treatment plant in an otherwise underdeveloped area could represent a significant impact. Non-structural control strategies may also create impacts on the visual environment, although these may be indirect.

There are five visual impact issues that may occur in the implementation of water quality strategies.

- Views and Vistas -- Perhaps the most identifiable visual issue is view blockage and vista intrusion. Along with treatment plants themselves, associated facilities such as fuel storage tanks and settling tanks can have view or vista impacts. By closing off a site to public traffic, the control can also block access to traditional vantage points from which views valued by the community could be seen. This type of impact is generally found with those control strategies involving the construction of large facilities, although any type of construction of buildings or landscape rearrangement has the potential for intruding on a vista.

- Visual Identity -- This is a more difficult issue as it involves the relationship between people's image of themselves and the way this image is supported or contradicted by their environment. The principal issue of concern in this factor is compatibility of the water quality control option as a use with other uses in the surrounding environment. For example, in more urbanized areas, the expansion of large scale centralized wastewater treatment plants is often a minor visual issue. They are often located on land zoned for other "nuisance" uses, such as industrial uses, and thus may not be perceived as a visual identity issue. Small scale treatment systems located in neighborhoods, on the other hand, may present genuine visual identity issues. They may be perceived as "out of character" in a neighborhood.

  Another issue in this category involves secondary development resulting from a water quality strategy. For example, the pattern and location of development changes with the provision of sewerage service, creating major changes in the density and architectural character of development in the community.

- Fit with Setting -- Within a more immediate radius of a water quality control facility, issues of fit with setting may be raised. This issue primarily relates to the construction of structural controls. Elements of concern include extreme contrasts of scale, development density, building materials, or architectural style between the facility and adjacent development.

- Visual Nuisance -- A variety of minor visual irritants may be associated with construction activities. Unscreened materials stockpiled, the sight of heavy equipment where it did not exist before, large expanses of cleared areas left unseeded for many months -- all of these are nuisances that can usually be avoided with a minimum of effort. There may also be minor nuisance elements during regular operations, such as glare from night lighting in parking or security areas.

- Natural Elements -- Trees, grass and other natural features are valued parts of the visual environment. Some control strategies will encourage the protection of natural features (e.g., erosion control). Others will mandate increased planting, or preservation of existing vegetation to control run-off. In rural areas, control strategies that replace the natural with man-made landscape elements can have an important impact upon the area's visual character.

IMPACT INDICATORS

The selection of impact indicators for this impact category is similar in nature to the historic resource impact category. Clearly, qualitative measurement is as important, if not more important, than quantitative considerations. It is essential in visual impact analysis to go beyond the issue of amount of visual impacts and to consider the type and severity of impacts. In fact, it is probably more appropriate to emphasize the type and severity of impacts. The quantification of visual impacts resulting from water quality strategies will often result in meaningless impact indicators.

In general, the use of ordinal type measurement is suggested for describing visual impacts. Thus for a particular water quality control, say, a sewage treatment plant, in a particular environment, adverse visual impacts may be described as follows: slight, moderate, significant. In certain situations, where a particular water quality control, such as a sewer interceptor, will affect many locations, it may be appropriate to quantify visual impacts. For example, the number of unique natural areas affected by the interceptor would be a useful indicator of visual impact.

PRELIMINARY CONDISERATIONS

The scoping analysis for visual impacts basically must determine whether changes in the visual environmeent will occur from water quality strategies. The first step in this screening step is to examine in more detail the characteristics of the control strategy. The water quality planner must identify aspects of a control strategy that will:

- block views or alter vistas;
- change the visual identity or character of the area;
- be incompatible with nearby development;
- create visual nuisances
- alter the existing balance between natural and built elements in the area's landscape.

In order to determine whether the proposed project has these characteristics, the planning agency should use a checklist such as the one presented in Exhibit 15-1. Because this is only a screening step, a site visit is not suggested in applying this checklist.

If the strategy appears to have these characteristics and is site-specific, then it should be mapped. Alternatives that cannot be described in terms of location should not be considered for further visual quality analysis.

MEASUREMENT TECHNIQUES

The focus of the assessment process should be to determine the type and severity of the potential visual impacts. This will require: 1) that the existing visual environment in the projected impact area be described; and 2) that the projected changes in the environment resulting from the water quality control be determined and evaluated.

Existing Visual Environment --

There are two issues that will complicate the ability of the water quality planner to describe the existing visual quality of the area around the project. One issue is viewpoint. The visual description of an area will vary with the perspective of the person and will vary over time as the perspectives of individuals change. Thus, newcomers to a suburban community from the city, may view their subdivision as "country-like" and in tune with nature. Older residents in the community may remember the area as a pleasant idylic meadow before the subdivision spoiled it. The second issue concerns level of effort. Visual analysis can be time-consuming in the context of areawide water quality planning. Clearly, the planning agency will have to budget its level of effort for visual assessment carefully with consideration given to the relative importance of visual issues with respect to other impact issues.

Exhibit 15-1

SUGGESTED CHECKLIST FOR VISUAL IMPACTS

Visual Impact Factors	Component	Questions
1. Fit with Setting	Massing	Are the height, bulk, setbacks, site coverage and open space patterns of project design compatible with that of the surroundings, especially at project edges?
	Form	Do major elements of architectural form -- roofline, solid/void relationship, windows, etc., correspond to those of the project's surroundings?
	Surfaces	Are the colors, textures and materials of the project surfaces comparable to those of the surroundings?
2. Visual Identity	Character	Will the proposed facility constitute a compatible land use in the community; will it encourage an increase in the rate and extent to which undeveloped land is converted to urban uses?
3. Views and Vistas	Sightlines	Does the facility design respect sightlines from public areas to views valued by the community?
	Vantages	Does the facility design conserve a valued vantage point on-site from which views are traditionally enjoyed, or does it create one?
	Vistas	Is the facility as a whole compatible with its setting where seen from afar? Will it encourage development that is compatible?
4. Visual Nuisances	Physiological Comfort	Does the facility provide conditions favorable to the ease and comfort of sight (no glare, shadows, flashing lights, etc.)?
	Physiological Comfort	Does the facility eliminate or screen visual nuisances or eyesores?
5. Natural Elements	Conservation	Does the strategy encourage the conservation or preservation of existing topography, vegetation, etc.?
	Landscaping	Does the control strategy provide or encourage the use of new natural features (i.e., planting shrubs, trees, grass, etc.)?

The art of visual assessment is a rapidly developing field. There are literally scores of techniques that have been suggested and used to assess visual quality. Three representative techniques that incorporate a range of staff and community input are shown in Exhibit 15-2. While it is more desirable to use project area residents for community input, it may be more appropriate in areawide planning efforts to rely on staff and citizens advisory committee judgements.

Visual Changes --

The most difficult task in visual quality assessment is predicting the impact of a project before it is actually built. Most project documents -- plans and elevations -- are abstractions. Only those experienced in the interpretation of these technical documents can predict with any accuracy what the building will be like when it is complete.

In order to gain a more realistic representation of the final product, a variety of simulation techniques have been developed. Each has its particular strengths, weaknesses, and usefulness in an assessment. The most common ones include:

- Rendered elevations, consisting of the building elevation overlaid with shade and color to represent materials, shadows, landscaping, etc. These have the advantage of being quick and inexpensive to produce, but are only as good as their execution. Often the omission of details will convey a false image of the project -- for instance, windows may be left white, rather than darkened in the way real windows appear.

  Rendered elevations are best suited to representing flat facades or projects: seen principally from the front -- store-front renovations, for instance. For most water quality projects, any of the following techniques will give a better picture.

- Measured perspectives are the most cost-effective and convincing of all representation techniques. When carefully prepared, the resulting sizes, shapes, proportions and juxtapositions are very much like what one would get in a photograph if the project were finished. The observer's apparent vantage point can be at ground level where it should be, and once the drawing is underway, it is not difficult to add neighboring buildings and landscapes in their true proportions and location.

  Selection of the vantage point is critical to the drawing: vantages can be selected to emphasize a project's greatest strengths, or hide its worst problems. As a general rule, the chosen vantage should be one from where people will commonly see the project: a major street or central public space, for example.

Exhibit 15-2

TYPICAL VISUAL ASSESSMENT METHODOLOGIES

METHODOLOGIES	BASELINE CATEGORIES	ASSESSMENT METHOD	RESOURCES REQUIRED	APPLICABILITY TO WQM PLANS
Burke's Photographic Method	Series of photographs or sketches which illustrate 5 types of views from roadways.	•Each view is given a numerical ranking to evaluate how the landscape deviates from the "characteristic" view. +1 - view is superior to the characteristic landscape c - characteristic landscape -1 - man-made object is non typical but does not detract x - zone is not visable	Staff person with sketching ability.	This assessment relies heavily on staff judgement and when used for rural areas in conjunction with other methodologies will require sketching to project the baseline
Leopold's Uniqueness Study	Physical, biologic and human interest features in 46 categories. These categories are grouped under landscape scale (e.g., spectacular scenery, grandeur), degree of wilderness and river characteristics.	Each item in the baseline is assigned a rating based on how prevalent the features are in the area (uniqueness) and the degree of aesthetic interest	Staff person and community input.	Categories used are mainly applicable to wilderness areas. However, the method of uniqueness rating can be used for the WQM assessment with the addition of community input.
Litton's Method	Visual appearance divided into landscape, setting and waterscape units. Each of these units is divided into sub-elements in which the elements are rated by unifying visual appearance using photos, sketches or written lists.	Natural feature components are rated as to unity, variety, vividness. Man-made elements are rated by unifying, focal, enclosing, organizing and modifying/enhancing characteristics.	Staff person.	Technique can provide information on actual impacts of WQM plan. However, needs to be used in conjunction with community input.

Source: U.S. Environmental Protection Agency. Environmental Assessment of Water Quality Management Plans, January, 1977.

- Retouched photographs involve taking pictures of the site and modifying them to the project as it will appear. These can accurately portray surrounding context along with the project design. Modifications may be quite simple, such as painting over parts of the picture, or making a drawing to cut out and paste on. For some projects, dropping in the new building over a photograph is a quick and inexpensive short-cut to constructing a measured perspective. There are, however, drawbacks to this technique. For instance, if the project involves a lot of clearance and the opening of new vistas, that information will not be in the photograph. Also, since there are no precisely measurable reference points on a photograph, it takes a skilled artist to produce an effect that is both realistic and reasonably accurate.

- Axonometrics have no horizon or vanishing point, and are cheaper and easier to draw than a measured perspective. They appear abstract, however, and their apparent vantage point is above the project, not at ground level.

  The strength of the axonometric is that it shows spaces, masses and voids in reasonably accurate relationships over a large area, a plus for very big projects. Because they are cheap, they are also useful in analyzing borders of projects in contrast to existing development.

- Models do what axonometrics do, only better, providing an excellent overall view of the project. The best models will use realistic scaled representations of materials, people, trees and cars, and may seem quite real indeed.

  Aside from their high cost, notable drawbacks include the generally small scales at which models are prepared, and the lack of a vantage point on the ground for the observer. These can be overcome by the use of close up photographs of the model, which observers "walk through."

When any of these techniques are used, the planning agency should keep the following in mind:

1. All simulations, no matter what form, should show adjacent off-site building, landscape and other context elements, unless the purpose is specifically limited.

2. Accuracy of shape, size and location are more important than fancy coloring or rendering. Three or four simple but accurate measured drawings from the most important vantage points will be more useful than one beautifully colored perspective.

3. Simulations should not introduce wishful elements, like trees bigger than the project will actually provide, or decorative sculpture that simply is not present in the plans.

4. For most projects, some combination of model and measured perspective(s) will probably be the best way of representing its real qualities. If a model is too expensive, then an axonometric is an inexpensive and useful substitute.

5. Almost any shading or coloring of plans and elevations will be more informative, for most observers, than unrendered line drawings.

DATA REQUIREMENTS

The data collection burden will vary according to the number of areas affected by control strategies and the extent of the visual impact issue in each of those areas. As previously mentioned, it is easy to get quite involved in collecting and recording data from on-site visits to affected areas. This obviously will be quite time-consuming if there are a number of visual impact areas to be assessed. The planning agency should carefully consider the data requirements for each of the techniques before beginning any visual assessment. Exhibit 15-3 summarizes data sources.

REFERENCES

Citations

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Exhibit 15-3

VISUAL QUALITY DATA SOURCES

Data Item	Data Source	Use
Project Area Land Use Map	See Land Use, Chapter 11	Scoping Analysis; Existing Visual Environment Assessment, Leopold's Uniqueness Study
Project Area Topographic, Vegetation and Surface Water Resources Information	U.S.G.S. Topographic Map U.S. Soil Conservation Natural Features Studies	Scoping Analysis
Project Area Existing Visual Environment - Type and style of buildings - Arrangement of buildings - Building materials - Open space patterns - Views & vistas - Significant natural & physical features - Existing visual nuisances	Site Visit/Photographs or Slides Site Visit/Sketches Site Visit/Verbal Descriptions and Maps	Existing Visual Environment Assessment
Project Visual Characteristics - Location - Size of structure - Height of structure - Form of structure - Surfaces of structure - Fencing - Natural features Retention	Project Engineer	Visual Changes Assessment - Rendered Elevations - Measured Perspectives - Axonometrics - Models - Retouched Photographs

15.2 NOISE[1]

IMPACT DESCRIPTION

Impact Definition

"Noise" can be defined as unwanted sound. Sounds become unwanted when they interfere with people's activities. The nature of noise is by definition subjective: a sound may be pleasant to one listener and irritating to another. Among the factors which contribute to an individual's perceptions of certain sounds as noise are:

- physiological differences in hearing ability;
- a person's expectations and desire for quiet;
- a recognition of the noise source;
- attitudes toward the noise sources that would predispose someone to tolerate (or be hostile to) the noise.

In addition, the context in which the noise is heard also has a bearing on a listener's reaction. Noise that interferes with sleep or relaxation may be perceived as more of a nuisance than noise that interrupts speech, radio or TV listening or phone conversations.

Impact Issues --

Three types of noise impacts are of concern:

- levels and types of sounds that produce annoyance or dissatisfaction in listeners (subjective);
- noise that interferes with activities such as sleep or speech; and
- noise that creates physiological impacts, ranging from a startle to an irreparable loss of hearing.

Water quality strategies will produce these types of noise impacts through noise-generating activities or equipment. Construction-related activities and operational activities are two ways of classifying noise impacts of water quality controls. All of the structural controls, such as sewage treatment plants, interceptors, stormwater detention facilities, incinerators, will involve construction phase activities that will produce noise. Although these impacts will be of a short duration, the construction equipment and truck traffic may pose severe noise problems for an area. Operational activities, on the other hand, pose long term noise problems.

There are two types of noise issues within the operational phase of interest in water quality controls: point source related noise, such as that from equipment (pumps, engines, etc.); and non-point source noise, such as that from traffic generated by a facility. Examples of the latter include sewage treatment plants and septage and sludge disposal areas.

IMPACT INDICATORS

Sounds are airborne acoustic signals that consist of small rapid fluctuations of air pressure above the mean atmospheric pressure. There is a well-developed measurement science for characterizing sound. There are four noise indicators or parameters that are used in assessing impacts:

- The magnitude of the fluctuation determines the loudness of the sound. This is measured on a logarithmic scale, in terms of decibels (dB), and is referred to as the sound pressure level (SPL) of the signal. A level of dB roughly equals the smallest magnitude that we are capable of hearing. Because of the logarithmic nature of the scale, SPL values cannot be added directly where there is more than one source. A ten-fold increase in the number of identical sound sources results in an increase in the SPL of 10 dB.

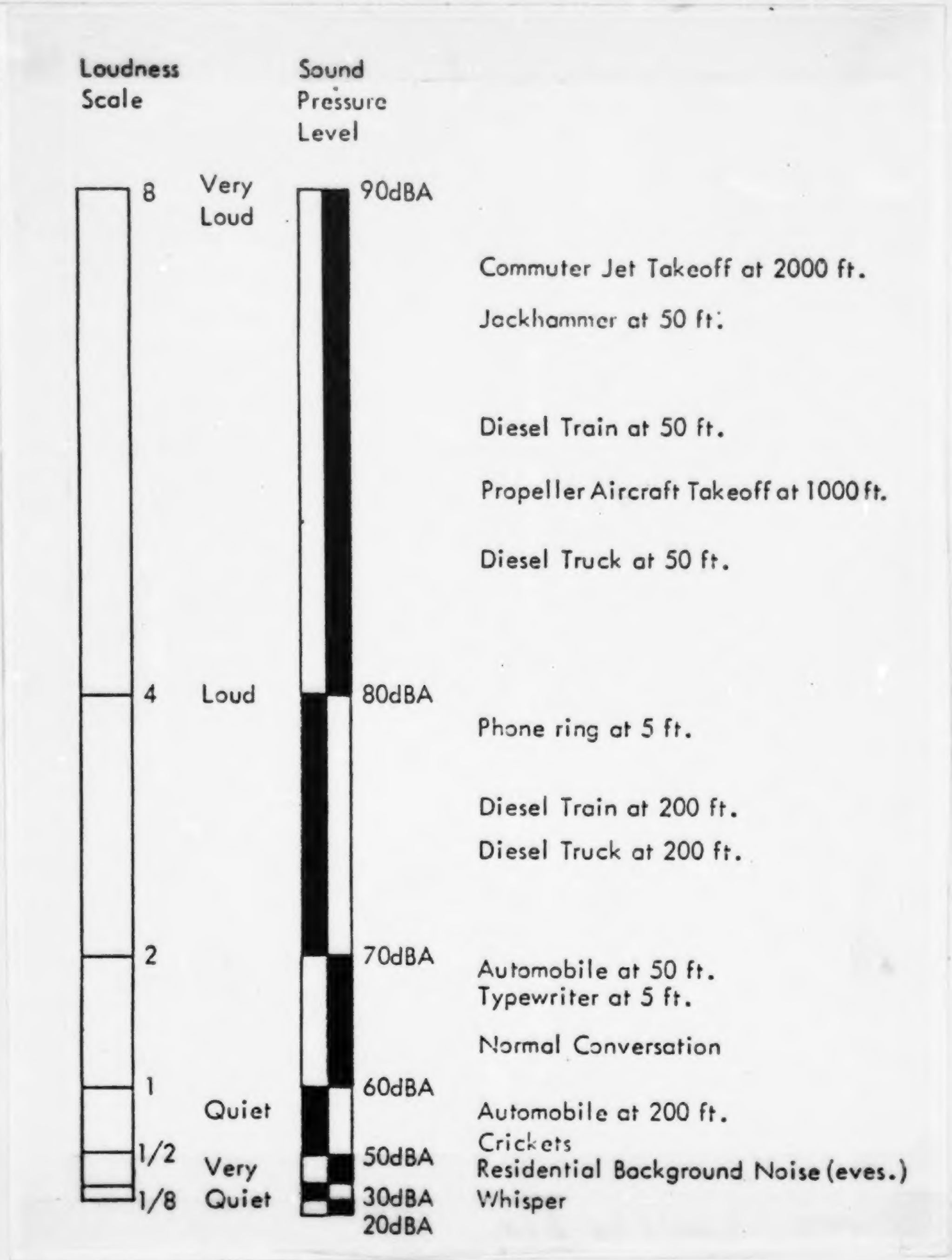
  The listener's distance from a sound source will also affect the magnitude of the noise. Where the sound is a point source (e.g., an idling bus), the SPL is reduced by 6 dB with every doubling of the distance. Where the sound is a line source (e.g., a heavily travelled highway), a doubling of the listener's distance from the source results in only a 3 dB reduction in SPL.

- The frequency of the fluctuation determines the tone of the sound. It is measured in Hertz (Hz), or cycle per second. While the human ear can hear sounds with frequencies ranging from 30 Hz to 15,000 Hz, we are most sensitive to frequencies in the mid-range. This bias toward hearing a certain range of frequencies is called the "A scale" characteristic. Most sounds contain a broad band of frequencies, rather than being made up of a single tone. The most common method of measuring this range of frequencies of community sounds is to use electrical filter that has a frequency response that is the same as the A scale characteristic in conjunction with a microphone. A meter calibrated in dB is then used to measure the filtered signal, which is then called the "A-weighted sound pressure level," or dBA. Some typical dBA level values for various community activities are presented in Exhibit 15-4.

- The variation of sound levels over time will affect the severity of noise impacts on a community. In a short period of time noise sources in a community produce a relatively constant sound level. However, over several hours, the variation in noise produced by automobile traffic, industrial activities, people's conversation, birds, etc. can be expected to be significant. In addition to the variation in background sounds, there are also sounds of short duration that also must be accounted for.

Exhibit 15-4

dBA LEVEL AND RELATIVE LOUDNESS OF TYPICAL INDOOR AND OUTDOOR NOISES



A community's total sound signal changes stochastically over time, as its component sources combine in a quasi-random fashion. This variation is measured by taking a set number of readings from a sound level meter over several hours. These readings are then converted to a continuous energy equivalent or LEQ level, which represents the dBA level of a constant sound which, over the same time period, carries the same amount acoustical energy as the signal measured in the community.. Frequently, the specified time period used is 24 hours; this measure is denoted as LEQ(24). Another measure which is also frequently used is the day-night equivalent energy level, or LDN. THis is computed in the same way as LEQ but includes a 10 dB penalty on SPL values measured between 10 pm and 7 am.

- Our perception of sound is also sensitive to its direction as signals travel from their source to a receiver. When measuring community noise levels, it is important to choose a site that allows the sound to travel freely (i.e. where there are few barriers) or sound-reflecting surfaces. Directional characteristics of signals are important in designing mitigation, as dBA levels can be reduced and/or redirected to a relatively insensitive area through the use of a variety of barriers.

Appropriate indicators for noise may involve one or more of these measurements linked to exposure. Useful indicators might include:

- Number of people impacted by a given noise frequency
- Number of people impacted by a given LEQ level
- Area impacted by a given noise frequency
- Area impacted by a given LEQ level
- Type of use impacted by a given noise frequency
- Type of use impacted by a given LEQ level

PRELIMINARY CONSIDERATIONS

Federal Noise Guidance--

The Environmental Protection Agency under the mandate of the Noise Control Act of 1972 is the lead noise agency at the Federal level. EPA is authorized under the Act to promulgate noise emission regulations for any product identified as a major noise source. EPA was specifically directed to consider products in the following categories:

- Construction equipment

275

- Transportation equipment
- Motors and engines
- Electrical or electronic equipmment

Regulations are gradually being promulgated in each of these areas, but in most cases, final regulations have not been published.

In addition to dealing with noise emitters at the product level, EPA, through the Quiet Communities Act of 1978, is attempting to stimulate the development of state and local noise programs to manage community noise problems. The 1978 Act is not a regulatory act, but rather uses grants and technical assistance to encourage state and local noise programs. EPA is also the coordinating Federal agency on noise assessment criteria.

From the standpoint of the generalized community level assessments required for water quality management options, the criteria promulgated by EPA[2] gears the assessment to the potential for both indoor and outdoor hearing loss and activity interference with LDN and LEQ(24) measures. These criteria, which are presented in Exhibit 15-5, are especially useful because they are tied to the various types of land uses/activities likely to be found in a typical community.

Scoping Analysis--

Similar to the Historic Resources and Visual Quality impact categories, the scoping analysis for noise should focus on eliminating for further noise assessment strategies that are not site-specific. The assessment of noise impacts is dependent on the noise sensitivity of an area around a project. Thus, the first step in the screening analysis is to preliminarily map the location of water quality projects that are potential noise emitters. In only the locations around these projects, then, would a screening analysis take place. A two-staged screening technique is proposed. First, a very rough approximation of existing community noise levels in the area can be made based upon measures of population density according to the following equation:

$$\mathrm{LDN} = 22 + \log p$$

where LDN = day-night energy average noise level measured in dBA, and
p = population density measured in people per square mile.

This equation predicts noise levels for residential areas in "typical" communities, and only indirectly accounts for traffic generated by nonresidential uses or other community-specific noise sources. Where this step indicates that community noise levels are relatively low (less than 45 dBA), then the types of land uses in the area should be more closely examined. If there is any development in the area, then the analysis should proceed to those steps suggested in Section 15.2.4. If the area is virtually vacant

Exhibit 15-5

EPA IDENTIFIED NOISE LEVELS REQUISITE TO PROTECT THE PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

YEARLY AVERAGE*EQUIVALENT SOUND LEVELS IDENTIFIED AS REQUISITE TO PROTECT THE PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

	Measure	Indoor Activity Interference	Indoor Hearing Loss Consideration	To Protect Against Both Effects (b)	Outdoor Activity Interference	Outdoor Hearing Loss Consideration	To Protect Against Both Effects (b)
Residential with Outside Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Residential with No Outside Space	L_{dn}	45		45			
	$L_{eq(24)}$		70				
Commercial	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	$L_{eq(24)}$	(a)	70	(a)			
Industrial	$L_{eq(24)(d)}$	(a)	70	70(c)	(a)	70	70(c)
Hospitals	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Educational	$L_{eq(24)}$	45		45	55		55
	$L_{eq(24)(d)}$		70			70	
Recreational Areas	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	$L_{eq(24)}$				(a)	70	70(c)

Code:

a. Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity. (See Figure D-2 for noise levels as a function of distance which allow satisfactory communication.)

b. Based on lowest level.

c. Based only on hearing loss.

d. An $L_{eq(8)}$ of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than an L_{eq} of 60 dB.

Note: Explanation of identified level for hearing loss: The exposure period which results in hearing loss at the identified level is a period of 40 years.

*Refers to energy rather than arithmetic averages.

with no adjacent recreational or agricultural uses, then the planning agency should consider eliminating the area for further noise assessment. Where the equation indicates that the community noise levels are already relatively high (above 45 dBA), then a more detailed assessment will probably be required only in light of additional information regarding specific noise sources. Generally, this issue is not usually a concern in areas of predominantly industrial or commercial uses, where overall noise levels are typically high to start with.

MEASUREMENT TECHNIQUES

The overall measurement approach for noise impacts involves an assessment of existing levels in a project area and an estimation of the changes in noise levels produced by the project.

Existing Noise Measurement --

Method 1: Mapping Approach

Under this approach, the planning agency relies strictly on inhouse, readily available information to estimate the noise levels of an area. In the area of the proposed facility, all sensitive receptors by type are noted: single-family residences, apartments, schools, recreation areas, etc., with approximate distances to the facility location. If possible, terrain and vegetation features, such as ground care, trees, hills, are noted. Finally, likely existing noise sources -- roads, factories, shopping areas -- are shown on the map. It might be possible also to obtain traffic information, if available, for the area. Using the noise level scale of Exhibit 15-4, make an estimate of the existing major source dBA level in the project area. It will probably only be possible to use an estimated range and it will likely take someone with noise analysis experience to make the estimation.

Method 2: Site Visit Approach

If it is possible to visit a site, it will be possible to obtain a much better estimate of existing noise levels. Two approaches are suggested. In one approach, which will be called Method 2A, a small hand-held sound level meter is obtained and dBA readings are measured at the site area. Meters may be borrowed from the EPA regional noise office or the state noise program if one exists. It will be necessary obviously to obtain advice on the use of these meters. If the noise issue is a major issue in the overall impact assessment, it probably will be appropriate to use EPA or state personnel for the actual measurement. In any case, average readings plus the range of dBA levels at each location should be measured. Noise contours should be mapped.

Method 2B assumes the unavailability of noise measurement equipment. In this approach, a qualitative approach is used. A batteryoperated cassette recorder is used to record sounds. Sample recordings should be taken at various location around the site. Use a voice-over to identify the locations on the tape or gaps in the taped signal (use the advance button or disconnect the microphone to provide the gap). Keep a written record of footages, control settings, and other pertinent information as an aid when playing back the tape. While a typical cassette recorder is not a suitable instrument for sound level recordings, a cassette recording can still provide useful information about relative levels, changes in noise level, fluctuation rates and other qualitative features of the noise climate. In addition to recording sound levels, take a camera along and take pictures of the area to give a total stranger a good idea of the total location.

Using the information from Method 2B, have a noise analysis expert from within the EPA regional noise office or the state noise office estimate the existing dBA levels in the project site area. If at all possible, visit the proposed location late at night as well as during the daytime hours. This is particularly important if there are residential receptors nearby, as nighttime residential noises are typically 10 dB or so less than normal daytime levels. If the proposed wastewater treatment facility is to operate on a 24-hour basis, the noise impact will be most severe during the nighttime due to the possible sleep interference effects. It is, therefore, necessary to quantify the existing community noise level during the critical nighttime period. If night visit cannot be made, the observed daytime levels should be reduced by 10 dB to estimate the existing nighttime noise level.

Estimating Noise from Control Strategies--

Given the level of detail that is likely to be available on the proposed water quality control strategy, it will be very difficult for the planning agency to accurately estimate the increase in noise emissions from a particular facility. Two approaches are suggested:

Method 1: Similar Facility Approach

In this method, a facility similar to the one in question is visited or information about it is obtained from the EPA regional noise office. If the facility is visited, and noise measurement equipment cannot be obtained, a subjective estimate can be made which would include the following information:

- What level of noise will the plant generate at some reference distance? A subjective evaluation -- loud (65 dBA or higher), audible (50 to 60 dBA), or just noticeable (less than 45 dBA) -- at some known distance from the approximate center of the plant, is suitable here.

279

- What frequency content can be expected? Fans, motors, pumps and other rotating or reciprocating machinery will have pure tone components -- usually at the fundamental blade passage rate for fans and compressors. The frequency content of various noises can also be described by phrases such as "clanging," "whish," "dull roar," etc., which give useful hints about the frequency content.

- What temporal variations can be expected? Seasonal variations in operations, number of hours per day and days per week of operation, plus types of noises -- continuous, intermittent, or impulsive -- should be noted. Nighttime operations are particularly important, if residential receptors are involved. Summer, versus characteristics, are also important, due to windows being open during the warmer weather.

- Directional characteristics should also be noted if they are obvious. Does an operating facility sound the same on all four sides, or are different sources audible in different locations? This type of information can be obtained by just walking around the outside of an operating plant and carefully listening to the noise signal at different locations.

Translate the above observations and information to the facility being assessed. If a visit to a facility similar to the one being assessed is made, then a hand-held sound level meter, a cassette tape recorder and a camera can be used in the same manner as in the baseline assessment to provide a record of noise levels at the "surrogate" facility. It may also be helpful to visit the project engineer/designer of the "surrogate" facility to obtain data on emitted noise levels.

Method 2: Control Strategy Performance Information

This method assumes a relatively well-defined facility in which it is possible to obtain specific information about the equipment to be used in the facility. A general configuration of the proposed facility is obtained, along with a description of the major noise emitted. These times would include ventilation systems, loading areas, falling water and other possible noise sources. Estimates of noise parameters, identical to those obtained in Method 1 are then attempted with the help of a project engineer for the proposed facility.

Impact Determination --

By comparing baseline noise levels with estimated noise levels of candidate control strategies, an estimate of the impacts can be made. In general, an increase in the LEQ(24) or LDN level of less than 5 dBA will result in only slightly discernible impacts. An increase of 5-15 dBA will result in moderate impacts, and an increase of more than 15 dBA will probably be quite severe. While the analysis outlined above should provide enough information for a preliminary assessment and screening, more detailed evaluation should certainly be undertaken where noise levels are expected to increase by more than 15 dBA. Where the area may be especially sensitive to noise impacts (i.e., a low-density residential area may be especially sensitive to increases in nighttime noise levels), an estimated increase in the range of 10-15 dBA probably should also result in a more detailed analysis.

DATA REQUIREMENTS

The data requirements for noise assessment can be extensive. Thus it is important to limit the assessment to only those facilities that are clearly of major concern. Suggested data items and sources are shown in Exhibit 15-6.

REFERENCES

Citations

1. This section relies heavily on Russell and Ivey. "Chapter 10 - Noise," in Environmental Assessment Manual, prepared by Anderson-Nichols, Inc. for U.S. ENvironmental Protection Agency, Region I. June 1978.

2. U.S. Environmental Protection Agency. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. EPA 550/9-74-004. March, 1974.

15.3 ODORS

IMPACT DESCRIPTION

Impact Definition

This impact category is concerned with one of the most objectionable sensory quality issues often associated with water quality controls -- namely, odors. As with noise impacts, people respond to different odors in different ways; an odor that annoys some people may cause serious health problems to others. Generally, the longer the time that odors can be detected in a community, the greater the number of residents who will notice them. Thus, a measure of intensity of odors detected in a community may not be a good indicator of levels of annoyance felt by residents. Rather, for many water quality problems, the existence of odors is a major indicator of the existence of the problem. Management strategies should be definition alleviate these odor problems. However, some strategies -- e.g., those involving land spreading of effluent and/sludge -- usually create odors at the facility site. Others, such as conventional sewage treatment plants, often produce odors if the facility malfunctions. While facilities are obviously designed to run well, the facility should provide for odor control or minimization as a contingency.

281

EXHIBIT 15-6

NOISE IMPACT DATA SOURCES

Data Item	Data Source	Use
Project Area Land Use Map	See Land Use, Chapter 11	Scoping Analysis; Existing Noise Measurement Assessment, Method 1
Project Area Population Density; Topographic and Vegetation Information	U.S.G.S. Topographic Service Map	Scoping Analysis
Project Area Traffic Information	Local or State Highway Department	Existing Noise Measurement Assessment, Method 1
Project Area Noise Levels	Site visit/sound level meter Site visit/cassette recorder	Existing Noise Measurement Assessment, Method 2
Control Strategy Noise Emissions	Similar Facility Actual Facility Performance Data	Impact Analysis

282

Impact Issues --

Generally, odor situations will be one of two types:

- Acute episodes, where an odor occurring only once and lasting no more than one day in a three-month period is detectible beyond the property limits of a source. These are usually the result of industrial accidents or unexpected malfunctions of industrial processes (which could include, for example, sewage treatment plants).

- Chronic situations where odors are discernible beyond the property limits of a source, lasting for more than one day in a three-month period or occurring more than once during this period.

Where the odors are caused by measurable quantities of pollutants, an air quality standard may be violated. However, pervasive odors may also be caused by immeasurable quantities of emitted substances. Sources of odors can be categorized as either point, where the type and quantity of the odorous emission can be identified and where the odor is confined to a specific area (e.g., industrial stacks or vents), and nonpoint, where the odorous substance is unconfined, such as with the application of wastewater effluent or sludge to land, or with malfunctioning on-site septic systems.

Generally, chronic situations produce more serious and more widely spread impacts than acute, or short-term episodes, where impacts are likely to be temporary discomfort and/or annoyance. Impacts resulting from chronic situations generally become more severe as the intensity of an odor increases from normal levels. Studies[1] have shown that the only measurable reaction to the vast majority of odor problems is annoyance, although severe chronic situations produce secondary socioeconomic and health effects, such as declining property values in areas with a history of odor problems and increased incidence of respiratory problems in especially severe situations.

IMPACT INDICATORS

Three measures are used to determine the extent of odor problems in certain areas. These are:

- Intensity of the odor, which is a numerical or verbal indication of the strength of the smell. This measure is directly dependent upon the concentration of the "odorant" or substance emitted by the source. This measure is characterized by evaluative phrases such as "boy does it stink around here," etc.

- Quality of the odor, which is a verbal description of an odor. This measure is based upon the vocabulary of the person making the assessment, and is normally expressed by means of a comparison with common odors (or odors for which a common name is customarily used). Exhibit 15-7 indicates several possible verbal scales that can be used to label various odors.

EXHIBIT 15-7

VERBAL ODOR DESCRIPTIONS

Henning's Odor Classification

(a) Spicy: conspicuous in cloves, cinnamon, nutmeg, etc.
(b) Flowery: conspicuous in heliotrope, jasmine, etc.
(c) Fruity: conspicuous in apple, orange oil, vinegar, etc.
(d) Resinous: conspicuous in coniferous oils and turpentine
(e) Foul: conspicuous in hydrogen sulfide and products of decay
(f) Burnt: conspicuous in tarry and scorched substances

Crocker-Henderson Classification

(a) Fragrant or sweet
(b) Acid or sour
(c) Burnt or empyreumatic
(d) Caprylic, goaty or oenanthic

Horstman Classification of Odor Descriptions

(a) Flowers
(b) Pulp mill
(c) Smoke, woodsmoke
(d) Burning leaves
(e) Mustiness
(f) Gasoline
(g) Rendering plant
(h) Rubbish burning
(i) Animal odors
(j) Miscellaneous odors

Source: Copley International Corporation, *National Survey of the Odor Problem, Phase I of a Study of the Social and Economic Impact of Odors.* Prepared for the EPA (NTIS: PB 194 376), January, 1970. pp. 12-13.

- Pervasiveness of an odor, or its ability to spread throughout a large volume of air and to persist at strengths sufficient to allow it to be detected over a wide area. A measure commonly used for this attribute of odors is the dilution threshold, which is an indicator of the smallest concentration of a substance that can be sensed under laboratory conditions and is compared with an observer's perception of the same odor in the field.

It is probably most appropriate to rely on qualitative measurement in this impact category. Thus ordinal measures such as the following should be used as indicators: slightly objectionable; moderately objectionable; highly objectionable. These can be expressed in exposure terms similarly to the noise indicators along area, population, and type of receptor dimensions.

It is also appropriate to consider frequency considerations in expressing odor impacts because of the susceptability of water quality controls to climate effects on operational problems. Some example odor indicators then may be expressed as follows:

- 100 acres exposed to moderately objectionable odors
- 75 homes exposed to 3-6 highly objectionable odor episodes each spring
- Cherry Hill recreation area exposed to continuous slightly objectionable odors

PRELIMINARY CONSIDERATIONS

The odor assessment should focus on site-specific strategies because of the location sensitivity of this sensory impact category. Thus, the planning agency in the scoping analysis should initially map the location of water quality projects that have been identified in the Impact Identification stage as potential odor emitters. Only in the locations around these projects, then, would a screening analysis take place. Using information on wind direction and topography and information on worst case situations involving facilities of similar type and size, an impact area should be defined in the scoping analysis. Information on odor problems for similar facilities can be obtained from the regional EPA office, particularly the Enforcement Division. The best proxies for the facility being assessed will be those in which meteorological conditions approximate those in the area of the proposed site. Information will be needed on the types of odors experienced, intensity of odors with relation to the type of wastes and the amounts handled, hours of operation of the facility, and the like.

MEASUREMENT TECHNIQUES

The assessment of odor impacts should attempt to refine the area of influence and attempt to estimate episodes and severity of odor impacts. Besides using EPA as a resource for defining the odor characteristics of different facilities, the planning agency should also consider contacting state water pollution control field inspectors and local officials in communities with similar facilities to determine the likely area of influence. The area likely to be influenced should then be mapped.

DATA REQUIREMENTS

The data requirements for the odor impact category are relatively modest and are shown in Exhibit 15-8.

REFERENCES

Citations

1. Copley International Corporation. National Survey of the Odor Problem. Phase II of A Study of the Social and Economic Impact of Odors. Prepared for the U.S. Environmental Protection Agency, 1972, p. 107.

Other References

- Copley International Corporation. National Survey of the Odor Problem. Phase I of A Study of the Social and Economic Impact of Odors. Prepared for the U.S. Environmental Protection Agency, January 1970.

- Copley International Corporation. Procedures for the Identification and Assessment of Community Odor Problems. Prepared for EPA, October, 1971.

- Goldsmith, John R. Health Annoyance Impacts of Odor Pollution. Prepared by California Department of Health for U.S. EPA, Human Studies Laboratory, National Environmental Research Center. EPA-650/1-75-001. October, 1973.

- Rains, Bernard A. Odors Emitted from Raw and Digested Sewage Sludge. St. Louis Metropolitan Sewer District, Missouri. Prepared for U.S. EPA, December, 1973.

EXHIBIT 15-8

ODOR IMPACT SOURCES

Data Item	Data Source	Use
Project Area Land Use Map	See Land Use, Chapter 11	Scoping Analysis; Assessment
Local Climate Information: - Annual Precipitation - Mean Temperature - Temperature Ranges - Humidity - Prevailing Winds	National Weather Service Local Airport Local University	Same as Above
Project Area Topography	U.S.G.S. Topographic Map Service	Same as Above
Characteristics from Similar Facilities	EPA Regional Office, Enforcement Division State Water Pollution Control Office Other Local Officials	Same as Above

CHAPTER 16

Public Health and Safety

16.1 IMPACT DESCRIPTION

Impact Definition

One of the basic purposes of a water quality strategy is to improve water quality. In most cases this will have beneficial public health impacts by reducing or eliminating bacteria and harmful toxic chemicals that might eventually reach humans.

The discussion in this section is aimed primarily at other public health and safety impacts, both direct and indirect, which may occur as a result of the strategy but which are not outcomes for which the strategy was intended. These other impacts may provide additional benefits and they may also have harmful negative effects.

Impact Issues

Water quality strategies will pose both measurable public health and safety effects and potential public health and safety risk issues.

Measurable Public Health and Safety Effects--

Typical public health issues associated with water quality strategies include:

- Urban stormwater source controls--improved street sweeping and litter control measures will contribute to environmental health goals, particularly in urban areas.

- Residuals management--may reinforce or improve existing solid waste disposal facilities and reduce the need for new landfill sites.

- Centralized wastewater treatment plants--may induce considerable growth and development in an area and result in increased mobile source air pollution.

- Sensitive area growth management controls--will contribute to public safety to the extent that development is prohibited in hazardous areas, such as flood plains and unstable steep slopes.

- Urban stormwater controls--will contribute to public safety to the extent that downstream flooding is minimized (a rare, but potentially very valuable impact).

Public Health and Safety Risk Issues--

If water quality strategies are well-defined, the above issues are reasonably predictable and measurable. The risk-related issues discussed here are far less predictable; by their very nature they are clouded with uncertainty. Some of the water quality impact issues that potentially increase or reduce public safety and health risks include:

- Stormwater detention ponds--may pose safety hazards to neighborhood children if not properly screened.

- Erosion sediment basins--may also pose safety hazards to neighborhood children.

- Reduction in chemicals for highway deicing--may pose additional driving hazards unless other snow and ice measures are instituted.

- The construction of water pollution control facilities, particularly sewer line excavation work, involves the risk of worker accidents.

- The operation and maintenance of water pollution control facilities, particularly treatment facilities and sewer lines, involves continual employee risks related to exposure to toxic chemicals or pathogenic materials.

- For every water pollution control facility there is the risk of system failure. Depending on the facility and its location, contamination may pose risks to individuals through a number of pathways--water-based recreation sites, groundwater contamination, or food chains.

While it is assumed that water quality strategies will meet water quality standards, as seen by this above list the implementation of some water quality strategies poses greater environmental risks than others. Of particular concern are wastewater controls discharging to surface or groundwater areas used for public water supply. Unless planned fail-safe mechanisms are inserted in operation and maintenance requirements for centralized wastewater treatment plans, for example, these facilities may pose health risks when operating or structural difficulties develop. Management is also crucial to the operation and maintenance of on-site systems in order to minimize failure.

Water quality strategies with the greatest potential public health hazards are land application techniques. When sludge or effluent is applied to land for disposal and/or agricultural uses, there is an opportunity for the bacteria and hazardous chemicals in the sludge to eventually reach a public water supply or recreational water facility. The most common path of movement to surface waters is with soil by erosion. Although less likely, hazardous bacteria and chemicals may enter into runoff which feeds into surface water. Also, the bacteria and chemicals may filter into groundwater supplies if the soil characteristics are not adequate. Contamination of water supplies is a very serious matter and any proposed land application of sludge or effluent must be examined carefully for its potential impacts. Even if the potentially affected water is not used for drinking purposes, chemicals may still enter the food chain, and/or the public may be exposed to bacteria by water contact.

Other hazards associated with land application techniques are:

- Effects on crop quality, especially the absorption of hazardous chemicals into the crops;
- Transmission of aerosols downwind potentially contaminating people or other areas;
- Propagation of insects that could be vectors in disease transmission.

16.2 IMPACT INDICATORS

Measurable Public Health and Safety Effects

Indicators for these effects are straightforward. Examples from the issues raised in Section 16.1 include:

- number of street miles cleaned per year
- number of tons of street litter collected per year
- number of non-compliant landfills eliminated or upgraded
- increase in capacity (tons/year) of acceptable solid waste disposal facilities

- increase in tons/per year of specific air pollutants (such as HC, SO_2, NO, TSP, etc.)
- amount (in acres) of hazardous areas removed from development capability
- amount (in acres or property value) of areas eliminated from flood risk or prone areas

Public Health and Safety Risks

Impact indicators for public health and safety related risks should encompass the following variables:

- population or resource at risk
- severity of the risk
- probability of the risk

Example indicators, using the issues listed in Section 16.1, include:

- Amount (in acres) of shellfish area exposed to a major wastewater treatment plant malfunction with a low probability of occurrence
- Number of workers exposed to sewer line excavation accidents with a moderate probability of occurrence
- Number of households with children living within 500 yards of a large stormwater detention pond
- Number of highway miles subject to road salt reductions and increases in automobile accident rates

16.3 PRELIMINARY CONSIDERATIONS

Public health and safety risks discussed in this chapter are probably the most speculative for water quality planners to deal with in the socioeconomic assessment process. If anything, by raising these issues you are likely to spur discussion that may result in either mitigation measures, monitoring systems, or contingency arrangements being considered to manage the risks posed by water quality strategies. Mitigation measures that do reduce or manage risk are likely to be in the form of more sophisticated operation and maintenance approaches. The greater the detail in a strategy description including its management arrangements, the greater reliability you have in doing risk assessments.

Even with highly detailed strategies, risk assessment may represent a block box in socioeconomic assessments for areawide water quality planning and facility planning efforts. Given the difficulty in doing risk assessment, it is suggested that your socioeconomic assessment limit risk assessments to the most important issues. It is possible to categorize and screen risk assessment issues by looking at the variables of probability of risk occurrence, risk magnitude, and value of the resource at risk. For example, given a number of resources at risk you may limit your analysis to only selected resources, such as drinking water supplies, types of recreation areas, certain population areas. Given this screening, you would then categorize the situation using the following matrix:

		PROBABILITY OF RISK OCCURRING		
		Low	Medium	High
RISK MAGNITUDE	Low	A	B	C
	Medium	D	E	F
	High	G	H	I

For example, you may wish to limit your analyses to situations E, F, H, and I where both the probability of occurrence and risk magnitude are "medium" or "high."

16.4 MEASUREMENT TECHNIQUES

Measurable Public Health and Safety Risks

The *direct* impact issues in this category should be relatively easy to quantify. If you have a well-defined control strategy, the impacts can be calculated without much difficulty. For example, the amount of additional litter that will be collected as a result of urban stormwater source controls can be calculated by:

1) Estimating the increased level of effort (in street miles or weather days) associated with the control strategy;

2) Estimating litter collection from past efforts in tons/street mile or tons/person-day level of effort;

3) Multiplying 1) by 2).

Changes in residuals disposal will depend on the control strategy. For example, if an incinerator is replaced by a resource recovery facility, you will want to calculate the reductions in tons/year of air pollutant emissions. If septage disposal lagoons are replaced by co-treatment strategy at a new regional wastewater treatment facility, you will simply estimate the number of sites eliminated or the gallons of waste diverted.

The most significant indirect impact issue in this category is the air quality issue. As discussed above, increased air quality emissions will increase with induced residential and employment growth in the area. Industry-related air quality emissions are too speculative to estimate at this point. Emissions related to residential growth are reasonably quantifiable. New residential growth will cause air pollutant emissions from:

1) motor vehicle trips related to the new housing,

2) on-site fuel combustion for heating and cooling of the new housing, and

3) off-site fuel combustion for generating the additional electricity required by the new housing.

On-site fuel combustion emissions from new housing as well as motor vehicle emissions will generally be released as an area source, i.e., at a low density over a large area. By contrast, the off-site fuel combustion for generating new electricity can be assumed to occur at one or more of the existing generating stations in the region.

Emissions can be estimated for six different pollutants related to the National Ambient Air Quality Standards: sulfur oxides (SO_x), total suspended particulates (TSP), nitrogen oxides (NO_x), non-methane hydrocarbons (NMHC), carbon monoxide (CO), and lead (Pb). Emissions should not be estimated for ozone (O_3) since this pollutant is formed in the atmosphere through a complex series of photochemical reactions. Control strategies for O_3 generally focus on emission rates for NMHC and NO_x. In urban areas, motor vehicles are the principal source of NMHC emissions, which are also referred to as volatile organic compounds (VOC). Fuel combustion normally produces small amounts of NMHC. Due to the fact that existing hydrocarbon emission factors for fuel combustion sources do not distinguish the methane portion, emission estimates for these sources are on the basis of total hydrocarbons (HC) only.

The air pollutant emissions estimated by this analysis can be translated into ambient air quality levels using available computer dispersion models. However, due to the extensive data input requirements of such models, you should not attempt to calculate ambient effects unless you have expertise available that is thoroughly familiar with air quality modeling.

Because of space limitations in this guidebook, the methods for calculating these air quality emissions are not presented here. The methods rely on a series of equations and emissions factors. For a 16 page explanation and examples for these equations, see Urban Systems Research and Engineering's Secondary Impact Assessment Manual referenced below. The equations and data inputs are quite manageable for both areawide water quality planning and facilities planning.

Public Health and Safety Risks

The level of difficulty for estimating risks in this impact category will obviously vary by impact issue. For example, the level of effort required to estimate the contamination of an aquifer by a large wastewater land application site is considerably greater than that for estimating risk associated with not using de-icing chemicals on a particular highway. In general, though, your analysis will include the generic steps outlined below.

Step 1.: Define the nature of the risk

In this step, you should define as concisely as possible the nature of the risk:

- type of health and safety effects that are at issue (e.g., automobile damage and injuries, food contamination, drownings, worker accidents, etc.)
- how the effects would occur, i.e., from weather related accident, a system failure, through normal operation and maintenance activities, through construction activities, etc.
- the frequency of the risk--chronic, highly variable, infrequent.

Step 2: Define population/resource at risk

In this step, you should attempt to determine how the risk described above might affect different receptors. Essentially, this step should trace the pathways that the risk-producing event is likely to follow and then characterize the population/resource that is at risk. For example, what would be the implications of a 4-hour or 1-day bypass at a proposed wastewater treatment facility? How far downstream will there be water-quality related public health effects? What resources (shellfish beds, recreational areas) would be affected? Similarly, at a proposed spray irrigation wastewater disposal site, what direction would aerosols likely follow? How far would this effect be felt? As seen from these questions, you will need to coordinate this assessment closely with the environmental issues and data collected for the proposed water quality strategy.

The description of the population/resource at risk should focus on basic characteristics. Examples include:

- Shellfish Area
    - location
    - size of area
    - average daily yield (in bushels or dollar value)

    - consumer market area

- Recreation Area
    - location
    - type of activities affected
    - number and type of users.

- Highway
    - location
    - area affected
    - average daily traffic

- Neighborhood
    - location
    - population characteristics

Step 3: Determine potential magnitude of risk

In this step, you will want to estimate in, at least a crude fashion, the likely consequences if a risk-producing event actually occurs. The step is largely concerned with developing crude damage functions.

An example of a typical S-shaped damage function is illustrated in Exhibit 16-1. The ordinate or damage can be expressed in a number of terms, e.g., individuals affected, dollar value, or physical size of aquifer threatened. The abscissa represents the dosage in terms of time at a given contaminant, pollution, or accident concentration. The lower portion of the curve suggests that, up to a certain exposure value, little or no damage is observed. The upper portion indicates that after a point, increased exposure does not produce additional damage. Exposure is the integral over time and of the ambient concentration to which the receptor has been exposed.

In addition to mapping the control strategy, the pathways, and the receptors at risk, you may estimate the actual magnitude of the risk consequence by:

- Using existing environmental models (e.g., surface water, groundwater, or air);

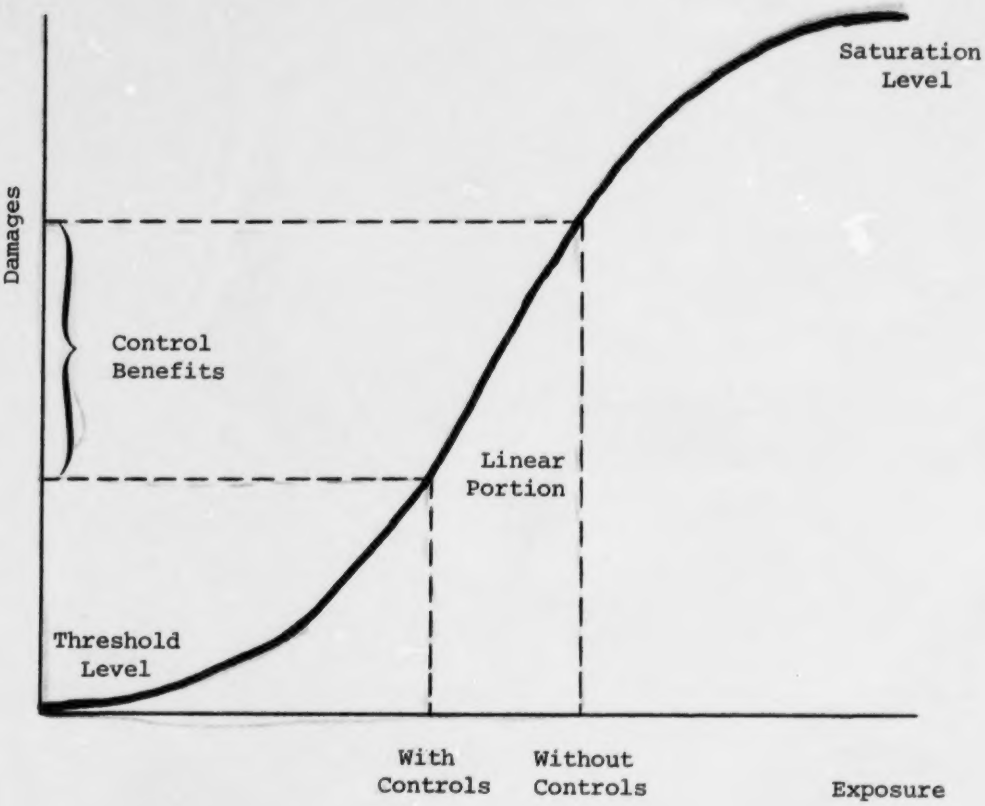
- Interviewing key informants (e.g., state public health specialists, local board of health officials, local public safety officials).

You will probably have to express any estimates in quantitative ranges or qualitatively using ordinal measures (e.g., severe, moderate, minimum).

295

Exhibit 16-1

HYPOTHETICAL DAMAGE FUNCTION



Step 4: Estimate probability of risk

It is absolutely encumbent in doing risk assessment to factor in uncertainty. In addition to using uncertainty envelopes above (ranges or ordinal measures) to describe the magnitude of the impact, you should also estimate where possible the liklihood of the risk-producing event occurring. Two approaches are suggested:

- Literature searches and trade association contacts - many of the activities that may result in a risk-producing event occurring have some type of statistical evidence associated with them. For example, the U.S. Department of Labor periodically publishes a "Handbook of Labor Statistics" which provides data on industrial accidents. They publish work-injury rates for, among other things, sewerage facilities (expressed as frequency of accidents per hours worked).

  Similarly, you can contact public agencies and private trade associations for other accident-related data, such as the National Highway Safety Board, and a local construction workers trade union.

- Similar facility approach - while the above approach is most useful for accident-related causes of risk, this approach is more suitable for water quality control system failures. In this approach, data is gathered on facilities similar to the one in question. You can, for example, talk with EPA regional and state officials to determine the type of problems that are occurring in other facillities. Differences in staffing and operation and maintenance should be related to these facility problems. In some cases, the regional office wil have good aggregate data on permit compliance, performance, and compliance problems for different types of facilities. The product of this search should be an estimate of the frequency of the risk-producing events that you are interested in, such as number of septic system failures per year involving breakouts, number of waste-water treatment bypasses per year (or month) for different types of comparable treatment facilities, number of aerosol incidents for comparable spray irrigation systems.

  Obviously, the validity of this approach is based on using data from "comparable" facilities. In situations involving performance evaluation across systems, it is crucial that variables on system age, size, treatment, and operation and maintenance parameters be examined closely.

16.5 DATA REQUIREMENTS

The data requirements for this impact category are shown in Exhibit 16-2.

EXHIBIT 16-2

Public Health and Safety Data Sources

Data Item	Data Source	Use
Water Quality Control Characteristics	● Facility Engineer ● 208 study	Determining risk-producing activities and events
Receptor Characteristics (examples: recreation areas, farms, fishing areas, neighborhoods)	● Local planning agency ● State natural resource agencies	Characterizing population/ resource at risk
Risk Consequences	● Literature search ● Key informants	Determining potential magnitude of risks
Risk Probability Estimate	● Literature search ● Similar facillities (EPA, state)	Determining liklihood of risk occurring
New Housing Units	Chapter 11 Analysis	Air density emissions analysis
Work Trip Length	Local transportation planning agency	Same as above
Residential Trip Generation Rates	Same as above	Same as above
Residential Fuel Use	State Energy Office	Same as above
Power Plant Fuel Use	Local utility company; state air pollution control agency	Same as above
Solid Waste Public Services Characteristics	Local department of public works	Public Health Benefit Analysis
Highway Data for Selected areas (accident rate, average daily traffic)	Local and State department of public work	Public Safety Analysis

16.6 REFERENCES

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APPENDIX A

Potential Socioeconomic Impacts of Water Quality Strategies

300

Appendix A: POTENTIAL SOCIOECONOMIC IMPACTS OF WATER QUALITY STRATEGIES

A-1 INTRODUCTION

This appendix presents a summary of potential socioeconomic issues associated with alternative water quality control strategies. The discussion focuses on the thirteen types of water quality controls listed below:

- On-site and alternative wastewater systems
- Conventional centralized wastewater systems
- Residuals management controls
- Infiltration/inflow and combined sewer controls
- Water conservation controls
- Industrial wastewater controls
- Urban stormwater source controls
- Urban stormwater flow attenuation controls
- Urban stormwater storage and treatment controls
- Urban soil erosion controls
- Agricultural source controls
- Growth management controls
- Hydrographic modifications

This classification scheme is designed to reflect the majority of water quality issues commonly addressed in water quality managaement planning. It is not intended to be inclusive. Certain water quality issues such as silviculture activities are particularly important in certain portions of the country.

For each of the water quality control categories in this appendix, examples of water quality controls are presented. Implementation measures and institutional arrangements, are not developed for each water quality control category because of the great potential variability at the local level. The discussion of socioeconomic impacts, however, reflects typical characteristics of implementation measures and institutional arrangements that might affect impacts.

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301

A-2 ON-SITE SYSTEMS

This control category is concerned with domestic wastewater systems where the generation, treatment, and disposal of waste is done on-site. On-site systems have traditionally been perceived by engineers and planners as a temporary wastewater management control in urbanizing areas to be eventually replaced by sewers and centralized treatment. This reasoning was primarily based on economies of scale, alleged failures with on-site systems, and groundwater pollution from on-site systems. While many of these assertions have been true in the past, on-site systems are currently enjoying a resurgence of interest by water quality planners. This rekindled interest is in part due to the growing costs--both capital and operational--associated with conventional centralized sewerage systems. For many communities, there simply is no cost-effective alternative to on-site systems. On-site systems, if properly installed and maintained, are now seen as attractive alternatives to conventional centralized systems. The 1977 Clean Water Act also recognized the on-site system as a legitimate means of wastewater management by enabling construction grant funds to be spent on the rehabilitation or replacement of existing (as of December 31, 1977) individual on-site systems if adequate future operation and maintenance of systems can be demonstrated.

1.0 Control Strategies

Issues to be addressed in the development of on-site control strategies potentially fall into three categories:

- Siting and installation of new systems
- Repair and/or replacement of existing and future problem systems
- On-going maintenance of all systems

Generally, on-site control strategies will encompass all of these issues. Some communities may have recently revised their on-site regulations regarding siting and installation but still may have inadequate measures for continuing maintenance and repairs. It is also likely that control strategies for any one issue will affect existing controls for the other issues. In developing on-site control strategies, the planner will also consider septage control strategies (See A-4).

In addition to the traditional septic tank and soil absorption systems, on-site systems also encompass less traditional means of disposal and treatment, such as waterless toilets. These include composting, incinerating, oil flush, and biological toilets. While these waterless toilets accommodate sanitary wastewater, a separate greywater system involving some type of soil absorption system is also required to handle other household wastewater. Waterless toilets are very often used in situations where a subsurface system has failed and repair is difficult.

2.0 Socioeconomic Impacts

The types of socioeconomic impacts associated with on-site systems are very dependent on the existing performance of on-site systems. The extent and type of problems with existing on-site system will naturally influence the type of alternative strategies to be considered. Strategies may encompass minor changes in the management of systems which will influence public fiscal costs or, at the extreme, they may involve extensive repair and rehabilitation programs. Public fiscal, individual costs/benefits, and land use impacts are the prominent socioeconomic impact issues associated with on-site systems. Exhibit A-2 illustrates these and other impacts.

3.0 References

1. The recent literature on on-site wastewater systems, particularly the management aspects, is becoming more extensive. For a comprehensive overview, see Hancor Inc., On-Site Waste Management, six volumes, variously published 1973-77 (available through Fred J. Crates, Director of Wastewater Management Systems, Hancor, Inc., P. O. Box 1047, Olive and Park Street, Findlay, Ohio 45840). For the only available bibliography of materials on on-site management, see Niehus, Don C., "On-Site and Alternative Wastewater Systems Management," August, 1978 (available from the author, U.S. Environmental Protection Agency, Facilities Requirements Division, 401 M Street S.W., Washington, D.C. 20460.

2. See 40 CFR 35 for provisions and constraints on use of EPA funds for on-site systems.

3. See HUD Handbook 4901.1, Division 15, Vol. 1, April 1977 (revised).

4. The size and type of system will depend on the soil permeability of the individual site and water quality constraints. Soil permeability will affect the size of the absorption system and costs may vary from $500 to $1,200. (These are 1976 costs. See Kriessl, James F., "U.S. Environmental Protection Agency Response to P.L. 92-500 Relating to Rural Wastewater Problems," in Individual On-Site Wastewater Systems, Nina I. McClelland, ed., Ann Arbor Science, 1977.) If soil is highly impermeable or high groundwater is a problem, then only more expensive options are feasible, such as mound systems or evapotranspiration systems. Because of groundwater or surface water quality constraints, systems that provide better treatment, such as aerobic systems, may be required.

Systems requiring larger land areas in conjunction with setback requirements may increase lot size requirements and thus land costs per dwelling unit. Water quality constraints may also increase land costs by requiring larger lots per dwelling unit. The key water quality parameter is nitrate which is not readily absorbed by the soil. The nitrate load to groundwater from on-site systems is reduced by decreasing the density of development.

303

Exhibit A-2

ON-SITE SYSTEMS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Private Firm Costs (1) Increases in development costs for developers installing new on-site systems	(1) Size and type of system will affect development costs[4]	(1) Regulatory requirements will affect size and type of system; regulatory procedures will affect length of development process and amount and type of planning requirements[5]; (1) Performance bonds	(1) If regional or state authorities must approve systems, review time might be more lengthy than a local management agency
Public Fiscal Costs (1) Increases in regulatory and administrative costs (2) Costs associated with public ownership and operation of facilities	(2) Size, amount, and type of facilities	(1) Increased regulatory and management involvement will stimulate higher regulatory and administrative costs (2) Public purchase of systems (2) Amount of outside cost sharing	(1) Distribution of regulatory requirements among local, regional, and state agencies will affect local public costs: distribution of management responsibilities between homeowner, private sector, and public authorities will affect local public costs (1) Type and amount of developer fees and inspection fees (2) Distribution of ownership of facilities between public and private sector
Individual Costs/Benefits (1) Changes in direct capital costs (2) Changes in operating costs	(1) Type of replacement system or rehabilitation required for problem systems[6] (1),(2) Type and effectiveness of maintenance practices[7]	(1) Type and effectiveness of design/installation/regulations[8] (1) Public cost sharing will reduce homeowner costs of repair or replacement (1),(2) Public acquisition (2) Operation/maintenance requirements (2) Public education	

Exhibit A-2 (continued)

ON-SITE SYSTEMS

Direct Impacts	Characteristics Affecting Impact Structural Control/Management Practice Characteristics	 Implementation Measures	 Institutional Arrangements
Land Use (1) Changes in growth pattern, i.e., the amount, type, density, location, and timing of growth[9]	(1) Type of on-site system used; use of on-site systems versus public sewerage facilities	(1) Health codes and regulations for on-site systems will affect lot sizes, allowable wastewater flows, and the rate of development and thus influences growth pattern (1) Public cost-sharing for rehabilitating or repairing on-site system problems will affect the economic ability of some communities and areas to remain on on-site systems rather than going to public sewerage	
Public Health (1) Changes in potential health risks associated with malfunctioning systems	(1) Type and effectiveness of maintenance practices	(1) Type and effectiveness of design/installation regulations	
Sensory (1) Visual nuisances (2) Odor nuisances	(1) Certain systems, such as mounds and evapotranspiration systems, may not be visually compatible in certain house lots with the overall landscaping (2) Type and effectiveness of maintenance practices	(2) Type and effectiveness of design/installation regulations	
Public Services (1) Changes in groundwater recharge[10] (2) Changes in water consumption demands[11] (3) Changes in public sewerage need[12]	(1) Number and density of subsurface systems (2) Size of systems; use of water conservation devices (3) Type and effectiveness of maintenance practices	(2) See Exhibit A-7 (3) Type and effectiveness of design/installation regulations	

Exhibit A-2 (continued) ON-SITE SYSTEMS

Direct Impacts	Characteristics Affecting Impacts		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Employment (1) Changes in employment for administration, planning, and management of on-site systems	(1) Type and number of facilities	(1) Type and extent of regulations	(1) Distribution of responsibilities between the public sector, and the homeowner

Indirect Impacts	Impact Stimulant	Discussion
Individual Costs/Benefits (1) Changes in property values (2) Changes in individual expenditures for public services	(1) Public health impacts; sensory impacts (2) Public service impacts	(1) On-site systems may have both adverse and beneficial impacts on property values. For example, poor system performance will tend to lower property values in existing development. In general, in areas without sewers vacant and suitable for on-site systems will have higher property values than unsuitable areas. In areas with sewers, and vacant sewered land, even properties with adequately performing systems will tend to have lower property values than sewered properties[13] (2) If demand for public sewerage or for system expansion is forestalled by adequately performing on-site systems, the on-site property owner will generally benefit by not incurring sewerage hook-up costs. Both sewered and non-sewered property owners will benefit by not having to pay for community-wide costs associated with a new or expanded public sewerage system. Similarly, changes in the need for water supply infrastructure affected by on-site systems will also affect individual expenditures. In both cases, the type of public financing for public services will affect the nature and distribution of individual costs.
Housing (1) Changes in housing availability	(1) Land use change	(1) As discussed in note 9 , on-site systems may affect the growth pattern. These effects may be reflected in the location of new housing, in the type of housing, and in the cost of housing.
Employment (1) Changes in employment opportunities	(1) Land use	(1) The effects of on-site systems on land use may affect the ability of an area to attract new businesses and to keep existing businesses interested in expanding.[14]
Population (1) Changes in the future population mix	(1) Indirect housing and employment impacts	(1) Changes in the availability of housing and jobs will affect population movement within a region.

5. For example, some communities require that soil permeability tests only be conducted during the wettest months of the year (e.g., April-June).

6. The existing site characteristics, amount of wastewater flow from a dwelling unit and the type of problem, affect the choice of repair of rehabilitation technique that can be used for problem systems. There are basically two types of problems: continuous problems or occasional problems. The latter may involve less corrective action and may be related to seasonal periods of the year or excessive water use. Corrective actions may range from low-cost water saving techniques to major reconstruction of a system.

7. Adequate maintenance will extend the longevity of an on-site system and thus decrease a homeowner's capital costs. These capital costs may be in the form of rehabilitation costs or replacement costs. The longevity of a system is also dependent on adequate design and installation as discussed below. For more discussion and verification of the relationship between system maintenance and system longevity see Clayton, J.U., "An Analysis of Septic Tank Survival Data from Fairfax County, VA," Journal of Environmental Health, 36:562-67; Hill, D.E. and C.R. Frink, "Longevity of Septic Systems in Connecticut Soils," Connecticut Agricultural Experiment Station: Bulletin 747, 1974; Saxton, Gary B. and Zeneski, J.M. "Prediction of Septic System Failures," Journal of the Environmental Engineering, June 1979, pp. 503-509.

8. Inspections, for example, during the installation are critical to the eventual success of an on-site system.

9. On-site systems have been viewed as both a friend and an enemy by those concerned with the land use effects of wastewater management. For example, some conclusions from a 208 study on septic systems in Delaware provide one viewpoint: "In urbanizing areas, septic systems should be considered as a temporary waste treatment method to be replaced by planned sewer construction. Liberal septic system policies contribute to urban sprawl, undermine urban planning, and subsidize fringe growth at the expense of the general public." (See "Septic Systems: A Case Study," New Castle County Areawide Waste Treatment Management Program, August, 1977). In contrast to this sentiment, on-site systems are often viewed by communities as a way to exclude rapid growth or high density residential development. See Jackman, R.D., "The Septic Tank's Role in Land Use," Conference on Land and Water Use in Oregon, Water Resources Research Institute, Oregon State University, Convallis, July, 1974, pp. 69-75; Twichell, J.H., "The Effects of the Use and Regulation of Septic Tank Systems Upon Land Use in Massachusetts," Water Resources Research Center, University of Massachusetts, Publication No. 96, January, 1978.

Amid these two viewpoints, are a variety of claims and counterclaims about the growth effects of on-site systems. The differences in opinion point out the difficulty in making definitive assertions about on-site systems. There has, in fact, been very little research on the on-site system/land use relationship that is valid beyond site specific cases. Some generalizations that can be made include the following:

- Any wastewater system will affect the ability of land to be developed. The extent to which on-site systems affect development ability depends on the land's capacity for development. This capacity may be determined by soil permeability, water quality constraints, or other physical constraints. In general, these capacity constraints will determine the use and type of on-site system possible and will be reflected in requirement in health codes and other regulations.

- The carrying capacity of land is also affected by the land use controls governing the use of the land. These controls may or may not reflect the physical and natural limitations of the land for development. Often development controls or land use regulations are not in harmony with the development capability of land. Land zoned for four dwelling units/acre may be only able to support one dwelling unit/acre. In this particular case, land zoned for one dwelling unit/acre may in fact be able to support four dwelling units with on-site systems. In this case, zoning serves as the development constraint.

- A key consideration in evaluating land use is the demand for development in a community and in a region. The amount of development demand and community and regional attributes, such as accessibility to employment centers, natural and man-made amentities, and the supply of vacant land are major factors influencing growth. In unsewered areas, the use of on-site systems may affect the distribution of this demand, the amount of development, the type of development, and the rate of development.

It is clear from the above points that any assessment of the growth affects of on-site systems can only be made after examining the following community and regional issues: the demand for development and the factors that shape development, namely vacant land, natural and infrastructure development constraints land use controls, amenities, accessibility, and community growth goals.

10. In developed areas that rely on septic systems and also obtain the water supply from shallow aquifers underneath the developed areas, the septic systems serve to recharge household water back to the aquifer. The removal of this recharged water by public sewerage may have significant effects on the groundwater levels. Portions of Nassau County, Long Island, for example that rely on groundwater for public water supply have experienced a drop in the water table due to sewering. This in turn has created a salt water intrusion problem. One report projected 5-20 feet drops in the water table under proposed sewering plans. See Kimel, G.E. and AW. Harbourgh, "Analog Model Analysis of Hydroligic Effects of Sewerage in Southeast Nassau and Southwest Counties, " U.S. Geological Survey, Mineola, NY Open File Report 75:535, October, 1975. A key consideration in this type of analysis is the amount of groundwater recharge from the domestic

watewater compared to the amount of recharge reaching the aquifer from precipitation and surface water sources. (See Chapter 12, Section 12.4.)

While there may be a positive quantity effects associated with septic system recharge, there may also in densely developed areas be an adverse quality affect. See, for example, Smith, S.O. and D.H. Myott, "Effect of Cesspool Discharge on Groundwater Quality on Long Island, NY," Journal of the American Water Works Association, Volume 67, No. 8, pp. 456-458, August, 1957.

11. If water conservation methods are instituted as part of an on-site wastewater management program, there may be positive effects on reducing the demand on public water supply (see Exhibit A-7).

12. If on-site system management reduces the number of on-site problems and failures, it may reduce the need for the extension of public sewerage into non-sewered areas. It is difficult to see how many on-site failures are necessary before public sewerage is required. The nature of the problem, the public health and water quality impacts, the community's development goals -- all must be considered in evaluating whether to correct existing problems or go to a centralized sewer system. See also "Technical Memorandum: Determining the Magnitude and Extent of a Need for a Public Sewerage System," Old Colony Planning Council, May, 1977, for guidance in determing the on-site system problems.

13. The theory behind higher values is often directly related to the development potential of the property. A sewered property, for example, has a greater potential for high density or non-residential use than a non-sewered property. See Milgram, Grace, The City Expands, Institute for Environmental Studies, University of Pennsylvania, Philadelphia, PA, 1967 for a study which used multiple regression analysis to establish the influence of sewers on land values. Federal regulations, such as those used by the FHA in evaluating properties, may also tend to increase land values for sewered property. (See note 3 above.)

In non-sewered developed areas, there also may be differences in property values attributable to the performance of on-site systems. In general, systems that perform will be reflected in higher land values. However, this may be a difficult correlation to make. For example, scattered problems on one street may influence the land values on the entire street.

A-3 CENTRALIZED WASTEWATER SYSTEMS

In virtually every areawide water quality study, a new centralizd waste- water system will be proposed or renovations/expansions to existing systems will be required. These proposals will form the framework for later more detailed facilities planning and assessment under Section 201 of the Clean Water Act. This section outlines some of the generic options that normally will be considered in the facilities planning portion of areawide planning. A complete municipal wastewater strategy will also likely include control techniques from Sections A-2, A-4, A-5, A-6 and A-7. Thus, socioeconomic impacts for municipal wastewater strategy would have to be aggregated across the various components.

1.0 Control Strategies

For the purposes of this socioeconomic impact guidebook, the discussion in this section will be limited to three types of controls: land application treatment and disposal systems; conventional treatment and disposal systems; and transport systems. Distinctions in control techniques within these general categories will sufficiently distinguish socioeconomic impacts.

Treatment

- Conventional systems, including lagoons, activiated sludge, other biological systems, physical-chemical systems
- Land application systems, such as irrigation, overland flow, and infiltration

- Subsurface disposal systems (see A-2)

Collection/Transport Systems:

- Conventional gravity sewers
- Pumping stations
- Small diameter gravity sewers
- Pressure sewers

Increased Operation and Maintenance (O&M) of Facilities:

- Personnel training
- Spare parts management
- Performance monitoring

2.0 Socioeconomic Impacts

The prinicipal socioeconomic impact issues associated with centralized wastewater systems are costs, the distribution of these costs to users and non-users, and land use charges. Exhibits A-3.1, A-3.2, and A-3.3 summarize these impacts as well as several other potential impacts assocaited with centralized wastewater systems. These exhibits consider land application impacts, conventional centralized treatment and disposal impacts, and collection/transport impacts consecutively.

The growth impacts associated with sewers, as seen in the Exhibits, have the most significatnt implications. Land use changes may stimulate a variety of indirect impacts, such as housing and population changes, public service demand changes, community aesthetic changes, and tax base changes. Because of the number of changes potentially triggered by growth changes, it is particularly important for water quality planners to isolate and estimate growth impacts.

While cost and growth impacts of sewers may have the most community-wide interest, there may be a considerable number of localized socioeconomic issues. As seen in the exhibit, these include public health, sensory, historic, and recreation impacts.

3.0 Exhibit References

1. Climate conditions which may limit continuous land application of effluent include severe cold when the ground is frozen and high precipitation periods when the ground is frozen and high precipitation periods when the ground is saturated.

2. The desired use is one of the most important factors affecting socioeconomic impact. A traditional land application notion is to simply discharge the effluent to some remote site for percolation into the ground. Other uses, however, clearly see the effluent as a beneficial resource. For example, potential uses that would enhance natural elements are irrigation and recreational lakes. Irrigation uses are numerous: public parks, rights-of-way, golf courses, and crops.

3. Aerosols are microscopic droplets that result from spraying operations. Aerosol travel and the transmission of pathogens depends on buffer zones, wind direction, and other climatic conditions. For additional material on public health issues associated with land application, see Metcalf and Eddy, Inc., Evaluation of Land Application Systems: Evaluation Checklist and Supporting Commentary, prepared for U.S. Environmental Protection Agency, March, 1975.

4. Depending on the type of industries tied into the municpal sewerage system and the type of pretreatment, there is a possibility of toxic contaminants being transmitted into the food chain.

5. Land application may alter groundwater flows and change the groundwater table as well as the direction of flow.

Exhibit A-3.1

CENTRALIZED WASTEWATER TREATMENT: LAND APPLICATION: POTENTIAL SOCIOECONOMIC ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Sensory (1) Increase in odor nuisances (2) Changes in local natural elements	(1) Extent to which buffer areas are included on site; extent to which holding ponds are needed because of climate conditions[1] (2) Use of effluent for irrigation or recreational lake purposes[2]		
Public Health (1) Increase in potential groundwater contamination (2) Increase in potential disease vectors associated with mosquitoes and rodents (3) Transmission of pathogens in aerosols (4) Increase in toxic contaminants in the food chain	(1),(2),(3),(4) Adequacy of treatment prior to land application (3) Use of spray systems[3] (4) Use of effluent for crops[4]	(1),(2),(3),(4) Extent to which monitoring precedures are required by regulations	
Public Services (1) Augmentation of water supply sources (2) Disruption of municipal water supplies (3) Change in drainage requirements	(1) Use of effluent for groundwater recharge or prevention of salt water intrusion; location and size of facility; type of treatment provided (2),(3) Groundwater conditions at location; amount of effluent applied[5]	(2),(3) Extent to which monitoring procedures are required by regulations	
Recreation (1) Changes in water-based recreational opportunities (2) Changes in land-based recreational opportunities	(1) Use of effluent to create artificial lakes (1) Loss of surface water below[6] (2) Extent to which effluent is applied to existing recreational uses or is used to create new opportunities[7].		

Exhibit A-3.1 (continued)

CENTRALIZED WASTEWATER TREATMENT: LAND APPLICATION

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Land Use (1) Pre-emption of land (2) Enhancement of existing land uses by the wastewater effluent (3) Changes in growth patterns, i.e., the amount, type, density, location and timing of growth	(1) Amount of land used exclusively for land application system[8]; multiple use opportunities (3) Capacity changes, treatment changes, facility location changes will all affect growth pattern	(1),(3) Cost sharing will affect facility sizing; regulatory requirements will affect capacity, treatment and location	(1) Type of ownership and operation[11] of land application sites
Private Firm Costs/Benefits (1) Decreased costs for water supply and fertilizer for agricultural users[12]	(1) Extent to which wastewater effluent is used for irrigation by agricultural sector (2) Municipal wastewater flows diverted from streams may allow additional industrial waste load allocations to occur	(1) Agreements between municipality and users of wastewater effluent	(1) Type of ownership and operation of land application sites (see note 11)
Public Fiscal (1) Increases in capital and operational costs associated with the facility (2) Increase in revenue from sale of wastewater effluent	(1) Size and type of facility (2) Use of wastewater effluent	(1) Costs affected by amount of outside cost sharing; compliance requirements of state and federal regulations (2) Regulations and permit conditions may affect use of wastewater effluent for irrigation or other uses (2) Existence of contracts/agreements with users of wastewater effluent	(1) Type of ownership and operation of land application sites (see note 11)
Employment (1) Changes in construction and operation employment opportunities associated with the treatment facility	(1) Size and type of facility		

Exhibit A-3.1 (continued)

CENTRALIZED WASTEWATER TREATMENT: LAND APPLICATION

Indirect Impacts	Impact Stimulant	Discussion
Land Use		
(1) Change in land uses adjacent to land application site	(1) Sensory impacts; public health impacts	(1) The frequency and magnitude of sensory and public health impacts may disrupt existing neighboring land uses or they may alter proposed development in the impact area around the land application site.
Public Fiscal		
(1) Loss of tax revenues (2) Changes in public service costs	(1) Loss of taxable land for land application site (2) Public service impacts	(1) As indicated in note 10, this impact depends on whether the land application site is publicly or privately owned (2) Possible changes in public expenditures for recreation, water supply, and drainage may result from impacts on these public services
Individual Cost/Benefit		
(1) Changes in homeowner wastewater user charges or property taxes (2) Decrease in property values adjacent to land application site	(1) Public fiscal costs (2) Sensory impacts; public health impacts	(1) See Section 3 for a discussion of public financing mechanisms and effect on users and non-users. (2) The impact on land values due to sensory impacts will likely be limited to a small area around the land application site. Public health impacts, on the other hand, may be more wide spread and land value changes more difficult to determine.
Population		
(1) Changes in the population pattern	(1) Changes in community growth patterns	(1) To the extent that sewer capacity affects local and area growth patterns--location, type, and amount of growth, there may be changes in future population amounts and types. (See Chapter 11 and note 17 below.)
Employment		
(1) Changes in employment of firms tied into municipal wastewater system or firms using the wastewater effluent	(1) Private firm costs/benefits	(1) Changes in the cost of wastewater management for firms tied into municipal system may be reflected in plant closings, reduced employment, or new plants moving into the area. (See Chapter 9.)
Private Firm Cost/Benefits		
(1) Changes in wastewater treatment costs for firms tied into municipal system[13]	(1) Public fiscal costs	(1) Changes in a treatment facility costs will be reflected in changes in wastewater costs and property taxes for industries. The type of public financing and the use of economic incentives will determine the type of cost effects for private firms.

Exhibit A-3.2 **CENTRALIZED WASTEWATER TREATMENT: CONVENTIONAL TREATMENT DISPOSAL SYSTEMS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES**

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Sensory (1) Changes in odor nuisances (2) Changes in visual nuisances; increase in visual conflicts; visual changes in natural elements (3) Changes in noise nuisances	(1) Type and effectiveness of O&M practices; extent to which buffer areas are used (2) Type of facility design; extent to which buffer areas are used; amount of construction-related and operation traffic (3) Extent to which buffer areas are used; amount of construction-related and operation traffic	(1) Type and effectiveness of design/installation requirements (1),(2),(3) Zoning ordinance	
Public Health/Safety (1) Increase in municipal facility operational accidents (2) Changes in potential health risks associated with malfunctioning systems	(2) Type and effectiveness of O&M practices	(1) Amount of technical assistance received; extent to which local sewer use ordinances restrict toxic materials entering the system (2) Type and effectiveness of design/installation requirements; allowed users downstream from facilities[14]	
Public Services (1) Changes in local water consumption demand[15] (2) Changes in local solid waste disposal demand	(1) Type of water conservation devices used (See A-7, Water Conservation) (2) Type of sludge management techniques used (See A-4, Residuals Management)	(1) Type of pricing mechanisms or other water conservation incentives used (See A-7, Water Conservation)	
Recreation (1) Changes in water-based and land-based recreational opportunities[16]	(1) Size and location of a facility		

15

Exhibit A-3.2 (continued) CENTRALIZED WASTEWATER TREATMENT: CONVENTIONAL TREATMENT AND DISPOSAL SYSTEMS

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Employment (1) Changes in construction-related employment (2) Changes in employment associated with municipal wastewater management	(1),(2) Size and type of municipal facility		(2) Distribution of functions among levels of government
Land Use (1) Changes in growth patterns, i.e., the amount type, density, location, and timing of growth[17] (2) Pre-emption of land	(1) Facility staging (design life and reserve capacity); type of treatment; service area size and location; extent of regionalization (2) Amount of land used exclusively for facility	(1) Cost sharing will affect facility sizing and service area; compliance requirements of state and federal regulations will affect capacity, treatment and location	(2) Type of public financing mechanism
Public Fiscal (1) Changes in capital and operational costs associated with the municipal facility	(1) Facility staging (design life and reserve capacity); type of treatment; service area size and location; extent of regionalization	(1) Type and amount of outside cost sharing; compliance requirements of state and federal regulations	(1) Amount of public ownership of sewerage facilities; type of public financing used
Individual Cost/Benefit (1) Change in property values of sewered property owners[18]	(1) Changes in capacity will affect sewered land, particularly sewered vacant land		

Indirect Impacts	Impact Stimulant	Discussion
Housing/Population (1) Changes in the availability of housing; changes in population mix and amount[19]	(1) Changes in community growth pattern	(1) The land use changes stimulated by public sewerage may affect the type, density, amount, and location of housing which will in turn affect population movement. (See Chapter 11.)

Exhibit A-3.2 (continued) CENTRALIZED WASTEWATER TREATMENT: CONVENTIONAL TREATMENT AND DISPOSAL SYSTEMS

Indirect Impacts	Impact Stimulant	Discussion
Recreation (1) Alteration of recreation uses adjacent to municipal treatment facilities (2) Changes in demand for recreational facilities	(1) Sensory and public health impacts (2) Population impacts associated with land use changes	(1) The location of a treatment in a recreation area may affect adjacent recreational experiences. (2) Population changes will affect recreation demand.
Private Firm Cost/Benefits (1) Changes in wastewater costs and tax burden for firms connected to municipal systems	(1) Public fiscal costs	(1) Changes in a treatment facility costs will be reflected in changes in wastewater costs and property taxes for industries. The type of public financing and the use of economic incentives will determine the type of cost effects for private firms. (See Industrial Wastewater Controls, A-5.)
Employment (1) Changes in employment for existing firms affected by private firm wastewater costs (2) Changes in employment due to accelerator effects (3) Changes in employment due to multiplier effect	(1),(2) Private firm costs (3) First and second-order employment changes	(1) These include reductions and expansions in employment for existing firms and job losses from outright plant closings (2) Certain industries may move to an area in response to relative changes in locational attributes such as the availability and cost of wastewater capacity (see Volume II, Section 4). (3) The demand for labor, land, or materials related to a strategy will create new demand for other goods. Firms moving into or leasing an area will also stimulate secondary employment changes. (See Chapter 9.)
Public Services (1) Changes in demand for all community public services	(1) Land use, housing, employment, population impacts	(1) The changes in community growth may affect the demand for public services and the performance of existing public services. (See Chapter 12.)
Public Fiscal (1) Changes in tax base (2) Changes in public service revenues/expenditures	(1) Employment changes; land use changes (2) Changes in public services demand	(1) The loss or increase of firms will affect the industrial tax base in the area. In addition, tax base changes will also result from housing/pouplation changes. (2) Changes in public service demand may have mixed effects on public revenues/expenditures. (See Chapter 7.)

Exhibit A-3.2 (continued) CENTRALIZED WASTEWATER TREATMENT: CONVENTIONAL TREATMENT AND DISPOSAL SYSTEMS

Indirect Impacts	Impact Stimulant	Discussion
Individual Costs/Benefits (1) Changes in wastewater costs (2) Changes in tax burden (3) Changes in property values adjacent to treatment facilities	(1) Public fiscal costs (2) Changes in tax base produced by land use and employment changes; changes in public fiscal costs for public service (3) Sensory or public health impacts	(1) The distribution of wastewater costs to individual properties will depend on the type of public financing used. (2) Changes in land use, particularly industrial and commercial land use, will affect existing residential tax burden. Taxes will also be affected by public service demand charges. (3) Adjacent properties may be adversely affected by the operation and location of treatment facilities.
Sensory (1) Changes in the visual character of the community	(1) Land use changes	(1) Land use changes that affect the amount, distribution, type, and location of growth may have both positive and adverse effects on the visual quality of an area. (See Chapter 15.)
Public Health (1) Changes in air quality	(1) Changes in the growth of an area	(1) Changes in land use, particularly in industrial and commercial uses, will increase or decrease stationary sources of air pollutants. Changes in the growth pattern will also affect air pollution from mobile sources. (See Chapter 16.)

Exhibit A-3.3 CENTRALIZED WASTEWATER TREATMENT: COLLECTION/TRANSPORT SYSTEMS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Sensory (1) Increases in noise nuisances (2) Increases in visual nuisances; increase in visual conflicts; visual changes in natural elements[20] (3) Changes in odor nuisances	(1) Amount of construction activity (2) Use and design of pumping stations; construction activity disruption; location and use of above-ground pipes; extent to which buffer areas are used (3) Type and effectiveness of O&M processes; extent to which buffer areas are used	(2),(3) Type and effectiveness of design/installation requirements	
Public Health (1) Disruption of rodent nests along rivers and waterways	(1) Construction activity; location of pipes		
Historic Resources (1) Changes in the number, type, location, use, and character of historic, archaeological and architectural resources[21]	(1) Construction activity; location of pipes		
Public Services (1) Increased demand on traffic control during construction (2) Disruption of groundwater supply sources[22]	(1),(2) Construction activity; location of pipes		
Private Firm Costs (1) Disruption of existing business activities[23] (2) Changes in development costs for subdivision developers	(1) Construction activities	(2) Local subdivision requirements; local urban service or capital facilities expansion requirements	(2) Distribution of construction responsibilities between developer and public sector

Exhibit A-3.3 (continued) CENTRALIZED WASTEWATER TREATMENT: COLLECTION/TRANSPORT SYSTEMS

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Land Use (1) Changes in the growth pattern, i.e., the amount, type, density, location, and timing of growth[24]	(1) Facility staging(design life and reserve capacity); location of pipes; types of sewer lines used; extent of regionalization	(1) Sewer extension regulations/policy; cost sharing; compliance requirements of state and federal regulations	(1) Type of public financing mechanisms
Recreation (1) Changes in water-based and land-based recreation opportunities	(1) Location of sewer pipes		
Public Fiscal (1) Changes in capital and operational costs associated with facilities[25]	(1) Facility staging (design life and reserve capacity); location of pipes; type of sewer lines used; extent of regionalization	(1) Cost sharing; compliance requirements of state and federal regulations	(1) Distribution of construction responsibilities between public and private sector; type of public financing used
Individual Costs/Benefits (1) Change in property values of sewered and previously unsewered properties[26]	(1) Location of sewer lines		

INDIRECT IMPACTS

Indirect impact issues for sewer lines will be similar to those for treatment facilities.

6. In areas where municpal discharges are transferred from surface water to land application areas, the flow loss may be significant enough to affect downstream recreation activities.

7. The use of effluent in public parks or golf courses may cause some disruptions. In general, where effluent is applied to land for reclamation or reforestation purposes, there will be positive recreational benefits. These will stem from increases in wildlife and vegetation. One of the most publicized land application systems in this country in Muskegon, Michigan reports new hunting activities, cross country skiing, and snowmobiling opportunities. See Mummert, P., "Recycled Wastewater Turns Muskegon's Economic Tide," ASPO Planning, August, 1978.

8. Soil types will have a major influence on the type of land application technique used -- rapid infiltration, overland flow, or spray irrigation. The type of technique will in turn affect the amount of land needed. Rapid infiltration requires far less land generally than the other two techniques.

9. The sewer/growth issue is, of course, one of the principal socioeconomic impact issues in areas experiencing growth pressures. There are several variables that affect this impact issue including: existing development constraints, the amount of additional capacity, the location, existing and proposed collection sewers, other growth constraints, and the timing of construction of the sewerage facilities. See note 17 below.

10. Many sewer commission or state regulations require that properties abutted by sewer lines tie into the sewerage system. The type of public financing, particularly the use of betterment assessments, will also affect the development of vacant land along the sewer line. See Chapter 2 on public financing mechanisms. Communities may also use phased infrastructure planning under a capital inprovement program to coordinate growth and sewers. See A-13.

11. There are numerous institutional arrangements that will affect this impact as well as public fiscal costs. In this particular impact, the ownership of the land is a key issue. If the land is owned by a public agency, the land may be considered pre-empted from other uses and taken off the tax rolls. The preemption issue may be muted, however, by any revenue derived from the land or by recreation uses possible on the site. In addition, the public agency may own the land and obtain revenue by leasing it.

12. In arid and semi-arid areas, the wastewater effluent may be viewed as a cheap or no-cost source of irrigation.

13. Depending on the previous costs for wastewater management, the new alternative may increase or decrease the cost of wastewater management for firms tied into the public system.

Additional Land Application References

Seabrook, Belford L., "Land Application of Wastewater with a Demographic Evaluation," in Proceedings of the Joint Conference on Recycling Municipal Sludges and Effluents on Land, National Association of State Universities and Land Grant Colleges, July, 1973.

Schmidt, C.J. and D.E. Ross, Cost-Effective Analysis of Municipal Wastewater Use, Prepared for U.S. Environmental Protection Agency, WPD-4-76-92, April, 1975.

Winn, Walter T., et.al., Recreational Reuse of Municipal Wastewater, Texas Tech University, Water Resources Center, July 1973.

Sullivan, Richard, H., M.M. Cohen, and S.S. Baxter, Survey of Facilities Using Land Application of Wastewater, prepared for the U.S. Environmental Protection Agency, July 1973.

14. Some states, such as Rhode Island, automatically classify water downstream of sewage treatment plants Class C in order to minimize public health problems if a facility malfunctions.

15. In areas that have been traditionally using on-site systems and where system performance is sensitive to water consumption, the implemention of a pubic sewerage system may stimulate increased domestic per capita water consumption. This hypothesis has not received adequate study. For one viewpoint, see Goldrosen, John, "Water Supply Impacts of Sewers," in Alternatives to Sewers: Conference Proceedings, Old Colony Planning Council, Brockton, MA, December 1976.

16. Above and beyond the recreational benefits of cleaner water that may occur, there may be both positive and adverse recreational impacts associated with the treatment facility. For example, the treatment plant site may provide or close off access to a waterfront area.

17. The effect of sewerage on land use is perhaps one of the most controversial socioeconomic impact issues in water quality planning. While there has been an increase in recent literature attempting to explain the relationship, the actual land use effects of sewerage are difficult to predict because of the numerous variables involved. For recent research and discussion on the topic see the following: Tabers, Richard D., et al., Land Use and the Pipe, Lexington Books, Lexington, MA, 1976; Bascom, S.E., et al., Secondary Impacts of Transportation and Wastewater Investments: Review and Bibliography, U.S. Environmental Protection Agency, January 1975; Urban Systems Research & Engineering, Inc., Interceptor Sewers and Suburban Sprawl: The Impact of Construction Grants on Residential Land Use, Volume I: Analysis, Council on Environmental Quality, September 1974; Downing, Donald, "The Role of Water and Sewer Extension Financing in Guiding Urban

Residential Growth," Water Resources Research Center Report No. 19, University of Tennessee, June 1972. (See also Chapter 11 of this guidebook.) Not surprisingly, each of the above studies have determined that sewer investments are key factors in shaping development.

18. If treatment plant capacity serves as a development constraint in sewered areas, then capacity expansion will tend to increase property values on vacant land.

19. As discussed in note 17, sewerage will affect the developability of vacant residential land. This may mean an increase in housing opportunity--both single family and multi-family units--in a community. The cost and the mixture of this housing will directly affect the type of population groups that will move [illegible] a community. Young families and other low income groups may find it difficult to move into a community where there are few multi-family units or low cost single family housing. This is, of course, a key socioeconomic issue in many communities where sewers are being proposed. The automatic response in some communities is to equate sewers with "low-income housing projects". Sewers may be rejected by these communities or sewer moratoria instituted as exclusionary devices.

20. Generally, the permanent visual issues of transport systems are associated with pumping stations, particularly where they are located in residential areas or in scenic areas. The construction of sewer lines, however, may also involve long-term alteration of the landscape. In addition, in some stream and river areas, the use of gravity systems will dictate crossing a river above ground rather than going below the stream bed. This can cause a permanent visual conflict.

21. The presence of historic resources is, of course, a necessity for impacts to occur in this category. The extensive landscape alteration associated with sewer line construction makes this a high potential impact issue. In particular, archaeological remains are often located near stream beds which is also an area where gravity sewer lines are often located.

Excavations for sewer lines in developed historic areas may also result in subsidence problems for adjacent properties. (See Chapter 14.)

22. Trenches associated with sewer line construction, particularly deep trenches for interceptors, may siphon off groundwater by diverting groundwater down the length of the sewer pipe. This may alter groundwater flows and in turn affect public and private wells located in the aquifer. Check dams at intervals along the pipe length may be required to prevent this phenomenon.

Areas using pressure sewers or vacuum sewers will be less susceptible to this problem because of the small trench depths. See Kriessl, J.F., "Alternatives for Small Wastewater Treatment Systems," U.S. Environmental Protection Agency, Technology Transfer, EPA-625/4-77-011, October 1977. Trenchless sewer construction techniques may also be possible for collector sewers to minimize groundwater disruption. See Beetschen, L.J., "Evaluation of Trenchless Sewer Construction at South Bethany Beach, Delaware," U.S. Environmental Protection Agency, EPA-600/2-78-022, March, 1978.

23. The construction of sewer lines in commercial areas will involve traffic and parking disruption that may temporarily affect adjacent businesses.

24. See note 17 for land use impacts associated with sewer line extensions and financing. Generally the use of alternative sewer collection systems--pressure sewers, vacuum sewers, and small diameter gravity sewers--will allow less excess capacity to be built into the collection system because of the smaller pipe sizes. A community may be able to limit growth associated with sewers, if desired, by using these alternative collection systems.

25. The primary factor in sewer line costs is the excavation cost which will vary by subsurface conditions and by type of area. There may be very high costs associated with construction in developed areas due to costs associated with locating and protecting other utilities and minimizing public convenience. Alternative collection systems are likely to have cheaper capital costs than conventional gravity lines because of cheaper excavation costs and pipe costs.

26. As discussed in note 17, sewer lines will tend to increase the development potential of abutting land, particularly vacant land. Higher values may also be attributed to sewered developed land than unsewered developed land because of the ability of sewers to remove the wastewater disposal problem off-site.

A-4 RESIDUALS MANAGEMENT

Sludge and septage management issues are important considerations in the selection and evaluation of wastewater management strategies. The treatment and disposal of residuals from both conventional sewerage systems and on-site systems be considered simultaneously in the planning for wastewater effluent treatment and disposal.

Of major concern in sludge management is the presence of heavy metals and other toxics. The ability to use land application of sludge, particularly for crops, is directly related to industrial waste loads. The disposition of sludge, then, is tied to the extent to which source controls and pretreatment measures are implemented by industries as required by local and federal regulations.

1.0 Control Strategies

Treatment technologies for both sludge and septage are fairly extensive as seen below. Ultimate disposal, however, for both residuals is limited--options are land disposal oriented. Ocean dumping is no longer acceptable under the 1972 Marine Protection, Research, and Sanctuaries Act (P.L. 92-532) and remaining ocean disposal practices are being phased out. The removal of this alternative will place even greater strain on land disposal options.

Sludge Treatment/Disposal Options

Treatment

- Dewatering:
  - --sand drying beds
  - --drying lagoons
  - --centrifugation
  - --vacuum filtration
- Stabilization:
  - --incineration
  - --chemical oxidation
  - --chemical treatment
  - --aerobic/anaerobic treatment

Disposal

- landfill
- land application

Septage Treatment/Disposal Options

Treatment	Disposal	
	Liquid	Solids
● Landfill	Ground percolation	Landfill
● Lagoon	Ground percolation	Landfill
● Wastewater treatment plant	Surface water; subsurface disposal; land application	Landfill
● Composting	Evaporation	Land
● Chemical oxidation	Wastewater treatment plant; subsurface disposal	Landfill; land reclamation
● Sand drying beds	Ground percolation	Landfill
● Land application	Ground percolation; evapotranspiration	Land

For the purposes of identifying socioeconomic impacts in this section, the impact discussion will be limited to the two major disposal options -- landfills and land application. In addition, impacts associated with incinerators will also be identified.

2.0 Socioeconomic Impacts

Since these structural controls generally involve public ownership, one of the important socioeconomic impact issues will be public fiscal costs. Public acceptance of these controls, however, will likely center around the sensory and public health impacts. The traditional perception of these facilities as nuisances makes theses socioeconomic issues primary candidates for special attention prior to public presentation. Summaries of the potential socioeconomic impact issues associated with incinerators, landfills, and land application (sludge) are presented in Exhibits A-4.1, A-4.2, A-4.3, respectively.

3.0 Exhibit References

1. Characteristics of the sludge and wind direction are also important in affecting the impact.

2. It may be economically practical to build a facility for use on a regional basis. In this case user fees from outside the locality could be used to pay the facility costs. The extent to which non-local users and commercial interests would use the facility would depend on how cost competitive the facility is with other regional and non-local alternatives.

3. See discussion under note 11, A-3.

Exhibit A-4.1

RESIDUALS MANAGEMENT: INCINERATION: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Sensory (1) Increases in odor nuisances (2) Visual conflict in fit with setting (3) Increases in visual nuisances due to traffic to the facility	(1) Operating and maintenance characteristics[1]; stack height (2) Stack height (3) Location with respect to residential areas	(1) Extent to which enforcement takes place to insure adequate operation and maintenance (2) Extent to which visual criteria required in design review	
Public Health (1) Increase in potential air pollution problems	(1) Operating and maintenance characteristics	(1) Performance requirements of federal and state air regulations	
Public Services (1) Increase in multiple use possibility for local solid waste management	(1) Extent to which design is compatible with residential solid waste processing		
Public Fiscal (1) Increase in capital and operational costs associated with facility (2) Increase in revenues from non-local and commercial user fees[2]	(1) Size and type of facility	(1) Costs are affected by amount of outside cost sharing; compliance requirements of State and federal regulations (2) Regulations and permit conditions may affect type and amount of users (2) Existence of long-term contracts with private sector or other communities (2) Extent to which state regulations are enforced to close cheaper alternatives (dumps) that are in non-compliance with environmental regulations.	(1) Type of ownership and operation ; type of public financing used

Exhibit A-4.1 (continued)

RESIDUALS MANAGEMENT: INCINERATION

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Employment (1) Changes in construction and operation employment opportunities associated with the incinerator	(1) Size and type of facility		

Indirect Impacts	Impact Stimulant	Discussion
Individual Costs/Benefits (1) Increase in homeowner wastewater user charges and/or property taxes (2) Decrease in land values	(1) Public fiscal costs (2) Sensory impacts; public health impacts	(1) See Chapter 2 for a discussion of public financing mechanisms and effect on users and non-users. The impact on land values, if there are sensory impacts, will be confined to a small area around the facility. Obviously, the siting process will attempt to avoid residential areas to avoid these impacts.
Public Fiscal (1) Decrease in overall solid waste expenditures	(1) Public service impact	(1) If the incinerator is designed to treat residential and other solid wastes in the community, it may reduce capital and operating costs associated with other facilities in the community
Land Use (1) Changes in existing or expected growth pattern in surrounding area	(1) Sensory impacts	(1) The impact of the facility on neighboring land uses will depend on the existing land uses in the area, i.e., whether they are compatible uses, such as industrial; whether the facility is being built in a new location; and the severity of the sensory impacts.

Exhibit A-4.2

RESIDUALS MANAGEMENT: LANDFILLS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Sensory (1) Increases in odor nuisances (2) Increases in visual and noise nuisances due to traffic to the facility	(1) Operating and maintenance characteristics (2) Location with respect to residential areas	(1) Extent to which enforcement takes place to insure adequate operation and maintenance	
Public Health (1) Increase in potential disease problems due to rodents	(1) Operating and maintenance characteristics	(1) Extent to which enforcement takes place to insure adequate operation and maintenance	
Public Services (1) Increase in demand on existing solid waste management facilities	(1) Extent to which use is made of existing solid waste facilities; amount of sludge/septage in relationship to existing capacity of solid waste facility		
Public Fiscal (1) Increase in capital and operating costs associated with facility (2) Increase in revenues from non-local and commercial user fees (see note 2)		(1),(2) See discussion for Incinerator alternative	(1),(2) See discussion for Incinerator alternative
Land Use (1) Pre-emption of land for public landfill	(1) Size and location of facility		

Exhibit A-4.2 (continued) RESIDUALS MANAGEMENT: LANDFILLS

Indirect Impacts	Impact Stimulant	Discussion
Individual Costs/Benefits (1) Changes in homeowner wastewater user charges or property taxes (2) Decrease in land values	(1),(2) See discussion for Incinerator alternative	(1),(2) See discussion for Incinerator alternative
Public Fiscal (1) Increase in overall solid waste expenditures	(1) Public service impact	(1) To the extent that sludge and septage disposal present increased demands on existing landfills used for solid waste disposal, additional capital and O&M costs may be incurred.
Land Use (1) Changes in existing or expected growth pattern in surrounding area	(1) Sensory impacts	(1) See discussion for Incinerator

Exhibit A-4.3

RESIDUALS MANAGEMENT: LAND APPLICATION: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Sensory (1) Increases in odor nuisances (2) Increases in visual and noise nuisances associated with truck traffic	(1) Extent to which buffer areas are included on site; extent to which holding ponds are needed because of climate conditions (2) Extent to which trucks, barges, or pipelines are used to ship sludge to site		
Public Health (1) Increase in potential groundwater contamination (2) Increase in potential disease vectors associated with mosquitoes and rodents (3) Increase in toxic contaminants in the food chain	(1),(2),(3) Adequacy of stabilization prior to land application (3) Use of sludge for crops	(1),(2),(3) Extent to which there are adequate pretreatment regulations; extent to which monitoring procedures are required by regulations	
Land Use (1) Pre-emption of land (2) Land reclamation	(1) Amount of land used for land application		(1) Type of ownership and operation of land application sites[3]
Recreation (1) Changes in land-based recreation opportunities	(1) Extent to which effluent is applied to existing recreational uses or is used to create new opportunities[4]		
Private Firm Costs/Benefits (1) Decreased costs for fertilizer for agricultural users	(1) Extent to which sludge is used by agricultural sector	(1) Agreements between municipality and agricultural users	(1) Type of ownership and operation of land application sites[5]

Exhibit A-4.3 (continued) RESIDUALS MANAGEMENT: LAND APPLICATION

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Public Fiscal (1) Increases in capital and operational costs associated with the facility (2) Increase in revenue from sale of sludge	(1) Size of facility (2) Use of sludge	(1) Costs affected by amount of outside cost sharing; compliance requirements of state and federal regulations (2) Regulations and permit conditions may affect use of sludge for other uses (2) Existence of contracts/agreements with users of sludge	(1) **Type of ownership and operation of land application site[6]; type of public financing used. (See Chapter 2)**

Indirect Impacts	Impact Stimulant	Discussion
Land Use (1) Changes in land use adjacent to land application site	(1) Sensory impacts; public health impacts	(1) The frequency and magnitude of sensory and public health hazards may disrupt existing neighboring land uses or they may alter proposed development in the impact area around the land application site
Public Fiscal (1) Loss of tax revenues	(1) Loss of taxable land for land application sites	(1) This impact depends on whether the land application site is publicly or privately owned
Individual Cost/Benefit (1) Changes in homeowner wastewater user charges or property taxes (2) Decrease in property values adjacent to land application sites	(1) Public fiscal costs (2) Sensory impacts; public health impacts	(1) See Chapter 2 for a discussion of public financing mechanisms and effect on users and non-users. (2) The impact on land values due to sensory impacts will likely be limited to a small area around the land application site. Public health impacts, on the other hand, may be more widespread and land value changes more difficult to determine.

4. See discussion under note 4, A-3.
5. See discussion under note 10, A-3.
6. See discussion under note 10, A-3.

A-5 INDUSTRIAL WASTEWATER CONTOLS

1.0 Control Strategies

While the list of control options below appears to be fairly extensive, many existing firms have rather limited abatement options because of their location, their production process, and their investment in existing abatement controls. For example, a firm discharging to a river in a heavily urbanized city generally does not have the option of discharging to land.

User charge and pretreatment requirements as originally formulated by P.L. 92-500 were intended to distribute the water pollution abatement financial burden to firms in an equitable manner. Despite these attempts, considerable variation exists in the actual costs each firm must pay. This is particularly true for firms tied into municipal systems. Some municipal facilities are located in water quality-limited stream reaches and face relatively stringent effluent limitations. Some public facilities are small and consequently they do not benefit from scale economies.

While local water quality planners may develop plans proposing alternatives for industries or develop implementation measures to guide their decision, the actual response by an industry will be largely based on the firm's internal analysis of the economic impacts of a variety of alternatives. These options may include one or more of the structural control/management practices listed below, non-compliance, business shutdown, decrease in business size, product or process changes, business relocation, or product price increases. Alternatives include:

- Pretreatment and discharge to municipal system
- Treatment and direct discharge to surface water
- Treatment and direct discharge to land
- Treatment and direct discharge to injection wells
- Joint pretreatment and discharge to municipal system or directly to surface water.

  In some industrial areas, plants in the same industrial sector tend geographically to cluster together. Examples include the jewelry industry, automobiles, steel, and food processing. Such geographical proximity may make joint treatment an attractive and feasible option.

- Process controls

  Faced with stringent effluent requirements and rising treatment costs, it may be cost effective for many industries to consider a variety of process changes to supplement end-of-the-pipe pollution abatement techniques. An industry may reduce its waste in several ways:

334

Water Reuse - This is particularly relevant for cooling water. For example, the meat processing industry has been able to substantially cut its wastewater by connecting to air cooled condensing systems or shell and tube condensing systems rather than barometric condensers.
Water Conservation - The major water using industries in the country--food, textiles, chemicals, pulp and paper--all are potential industries for water conservation. As wastewater user charges and water intake prices increase, process changes to achieve water conservation become more desirable. At the present time, several water conservation demonstration projects are being conducted in the food processing industry.
Waste Segregation - Many industries find it possible at minimal cost to reduce waste load concentrations by separating wastes from the effluent stream. The residuals could then be managed as a solid waste problem or, if feasible, used in a product recovery operation.

2.0 Socioeconomic Impacts

Depending on the amount of industry in a local area, the actions taken by firms with respect to industrial wastewater may have resounding socioeconomic implications in an area. The type of action that a firm will take in response to potential increased costs will be affected by several factors: plant efficiency, plant size and age, firm size, market position, profitability, capital structure, and production processes. Depending on the action by the plant, the types of major indirect socioeconomic impacts that may occur include: employment changes, public service demand changes, land use changes, and public fiscal changes.

Because of the significant socioeconomic implications associated with plant closings, EPA in conjunction with the Department of Labor maintains an Economic Dislocation Early Warning Systems (EDEWS) which attempts to monitor and track job losses attributable to EPA pollution abatement programs. Information on plant closings attributable to EPA water pollution abatement programs is available from the EPA regional offices.

Because this guidebook is geared to local socioeconomic impacts, there is no attempt to deal with national or multi-regional impacts. For example, one of the responses of a local firm to water pollution requirements is to simply pass along the costs to consumers. While these higher prices are a socioeconomic issue, they are beyond the scope of the guidebook.

Exhibit A-5 summarizes some of the potential socioeconomic impacts associated with industrial wastewater controls.

Exhibit A-5

INDUSTRIAL WASTEWATER CONTROLS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Private Firm Costs/Benefits (1) Changes in wastewater management costs for direct dischargers (2) Changes in solid waste management costs (3) Changes in water supply costs	(1),(2) Joint treatment may offer economies of scale; process controls may reduce size and/or type of treatment facility (2) The removal of wastes via process controls will increase industrial solid wastes	(1),(2),(3) EPA/state NPDES permit; new source performance standards; local waste load allocations; availability of technical assistance; extent to which state and federal tax and loan incentives are used	
Public Fiscal Costs (1) Changes in public wastewater management costs	(1) Amount and type of industrial waste load connected to municipal system; size of municipal facility; extent to which process controls are used	(1) EPA and local pretreatment regulations; industrial cost recovery formula; type of sewer user charges; type of water price structure used[6]	(1) Amount of distribution regulatory/enforcement functions; type of financing used
Land Use (1) Increases in existing industrial land use (2) Redistribution of industrial land use[7]	(1) Expansion due to industrial wastewater control technique (e.g., direct land application of industrial wastes) (2) Capacity of municipal treatment facility; availability of joint pretreatment facilities	(1) EPA/state NPDES permit; local waste load allocations (2) ICR; EPA and local pretreatment regulations; municipal user charges; water use pricing structure	
Public Services (1) Changes in local water consumption demand (2) Changes in solid waste disposal demand	(1),(2) Use of process controls	(1) ICR; municipal user charges; water use pricing structure (2) EPA and local pretreatment regulations	

Exhibit A-5 (continued) INDUSTRIAL WASTEWATER CONTROLS

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Employment (1) Changes in construction-related employment (2) Changes in employment associated with municipal wastewater management	(1),(2) Type and size of industrial facilities and municipal facilities accomodating industrial waste		

Indirect Impacts	Impact Stimulant	Discussion
Employment (1) Changes in employment for existing firms affected by industrial wastewater controls (2) Changes in employment due to acceleration effect (3) Changes in employment due to multiplier effect	(1),(2) Private firm costs (3) First and second-order employment changes	(1) These include reductions and expansions in employment for existing firms and job losses from outright plant closings. (2) Certain industries may move to an area in response to relative changes in locational attributes such as the availability and cost of wastewater capacity (see Volume II, Section 4). (3) The demand for labor, land, or materials related to a stragtegy will create new demand for other goods. This indirect demand, or multiplier, will stimulate further employment changes. (See Chapter 9.)
Public Fiscal (1) Changes in tax base (2) Changes in public service revenues/expenditures	(1) Employment changes; land use changes (2) Changes in public service demand	(1) The loss or increase of firms will affect the industrial tax base in the area. In addition, tax base changes will also result from population changes stimulated by direct and indirect employment changes. (2) The changes in public service demand may have mixed effects on public revenues. A decrease in water use by industry, depending on the pricing structure, may significantly decrease revenues.
Private Firm Costs/Benefits (1) Changes in wastewater management costs for firms connected to municipal systems	(1) Public fiscal costs	(1) Changes in a treatment facility costs will be reflected in changes in wastewater costs and property taxes for industries. The types of public financing and the use of economic incentives will determine the type of cost effects for private firms.
Individual Costs/Benefits (1) Changes in tax burden (2) Changes in wastewater costs	(1) Changes in industrial land use; public service demand (2) Public fiscal costs	(1) Changes in the industrial tax base will likely affect the tax burden of residential. These tax base changes could, however, be offset or intensified by changes in public service demands. For example, an increase in industrial tax base could be offset by increased costs for a new municipal water supply well.

3.0 References

1. Write the Industrial Development Research Council, Conway Research, Inc., Peachtree Air Terminal, Airport Road, Atlanta, Georgia for information on individual state pollution control incentives.

2. The 1977 Clean Water Act instituted an "EPA Civil Penalty Policy" for firms that have delayed compliance with regulations. From an economic point of view, it is generally in a firm's best interest to delay the commitment of funds for pollution abatement equipment. EPA has devised complex formulas for calculating the "economic benefit" of delayed compliance to determine the fee to be charged a firm. See Bureau of National Affairs, "The Environment Reporter: Current Developments," October 13, 1978, p. 1146.

3. ICR charges may have mixed results. Theoretically, they are designed to equalize capital costs between direct discharges and industries connected to municipal systems. At first glance, however, the economies of scale offered by a municipal system and the interest-free aspect of ICR would tend to favor industries connected to municipal systems.

4. Sewer user charges may increase industrial wastewater costs but they may also serve as an incentive to reduce waste generation and thereby reduce overall wastewater costs. See, for example, Bundgaard-Nielsen, M., "A Note on the Use of Economic Incentives in Water Pollution Abatement," Water Resources Bulleting, August, 1976, pp. 755-758. Herzog, H.W., "Economic Efficiency and Equity in Water Quality Control: Effluent Taxes and Information Requirements, "Journal of Environmental Economics and Management, 2, 1976, pp. 170-184.

5. Similary higher water prices may increase industry's water supply costs to a point, but they also may serve as an incentive to reduce consumption and thereby lower overall water supply costs.

6. See Exhibit A-7.

7. The availability or lack of availability of industrial wastewater capacity in an area may serve as one of many locational attributes affecting the location of firms.

A-6 INFILTRATION/INFLOW AND COMBINED SEWER CONTROLS

During intermittent wet weather events, the capacity of public sewerage systems is frequently overtaxed by excessive flows. These flows are often bypassed by the treatment plant and discharged directly without treatment. These excessive flows are the result of several factors: combined sewers; inflow due to direct connections between the sanitary and storm sewers, improperly located sanitary sewer manholes, or downspouts connected to the sanitary system; and infiltration due to high groundwater levels and leaky sewer pipe joints.

1.0 Control Strategies

Alternatives include:

- Sewer Separation - This approach involves the construction of separate sewers to transport sanitary wastes to a wastewater treatment facility. While providing the most satisfactory solution with respect to handling of sanitary wastes and the proper operation of wastewater treatment facilities, sewer separation does not contribute in any way to stormwater management.
- Flow Control - In-line devices are used to regulate sanitary sewage flow during dry weather providing periodic flushing of the combined sewers preventing the build up of solids. Systems have been proposed using various types of flow control devices including gates and inflatable dams. An advantage of the flow control option is that the same equipment could be used to control stormwater flows. However such in-line storage of combined sewer effluent would only be useful for relatively small storms for which the in-line capacity of the system were not exceeded. Large storms would result in discharges.
- Detention - Provision of sufficient end-of-the-pipe detention would ensure that the initial, highly contaminated slug of storm water from a combined sewer would not be discharged to the stream. Instead, the wastewater would be stored until it could be discharged to the wastewater treatment facility at an acceptable rate. Detention measures include underground tunnels and tanks or surface ponds and basins.
- Separate Storage/Treatment - A final approach involves the separate treatment of all combined sewer effluents during storm periods. This approach can be combined with detention or flow control techniques. Treatment generally involves mechanical separation of solids, such as using swirl separators, and disinfection. Such limited treatment of combined sewer effluent may not provide the maximum protection from contamination by sanitary wastes. However it may be a very effective way of reducing the impact of storm water. In some cases the net result may be that limited treatment of combined sewer effluent may provide the best overall protection of water quality.

- Inflow - The strategies to deal with inflow can be structured similarly to those for combined sewers, except that sewer separation would not apply.

  In many cases surveys will indicate that the few major inflow problems, such as storm pipe construction, are contributing to the majority of storm flow to the sanitary system. In such cases, the actual reconstruction/correction of the problem may be desirable. Disconnecting individual drain spouts that drain into the sanitary sewers from buildings may also be verified by the field survey as an effective means for reducing storm flows. In still other cases, there may be hundreds of points in the system where flow is entering. In these situations, it may be more cost-effective to consider end-of-the-line approaches, i.e., increase capacity of storage/treatment facilities.
- Infiltration - Groundwater infiltration occurs either through holes in the sewer pipes or, more likely, through poor connections between pipes. The principal solutions are to reline portions of the system with polyethylene pipe for example; to replace problem pipes and connections; or to regrout pipe connections. This technique can be very cost-effective, but may be limited to areas where a portion of the system has to be replaced because of overloading.

2.0 Socioeconomic Impacts

Socioeconomic impacts in this control category primarily result from storage/treatment facilities and sewer system rehabilitation projects. Storage/treatment impacts are similar to those discussed in A-10. Sewer system rehabilitation projects encompass infiltration connections, inflow connections, and sewer separation. Impacts stem primarily from the construction aspects of those projects as well as from the costs associated with those projects.

Of the sewer rehabilitation controls, sewer separation will particularly effect traffic in heavily travelled areas. A more serious public service impact may occur in aquifer recharge areas used for municipal water supply. Any type of sewer rehabilitation work in these areas may disrupt normal groundwater flows as well as pose contamination problems. The limited amount of cost sharing for sewer rehabilitation projects may mean significant public fiscal cost impacts and consequently significant individual cost impacts. It is because of these cost-related impacts that sewer rehabilitation alternatives do not generally fare as well as end-of-the-line storage/treatment alternatives in alternatives evaluation.

3.0 General References

Weston, Roy F., Inc. *Combined Sewer Overflow Alternatives*. Prepared for U.S. Environmental Protection Agency, 1970.

Amy, G. *et al.* *Water Quality Management Planning for Urban Runoff*. Prepared for U.S. Environmental Protection Agency, 1974.

Poertner, H.G. *Practices in Detention of Urban Stormwater Runoff: An Investigation of Concepts, Techniques, Applications, Costs, Problems, Legislation Aspects and Opinions*. American Public Works Association, 1974.

A-7 DOMESTIC WATER CONSERVATION

While water conservation strategies are currently receiving considerable attention in terms of water supply management, there is also a growing interest in using them as a wastewater management technique. Water conservation strategies can be used to reduce sanitary wastewater flows to both public facilities and to private on-site sewerage facilities. Thus, they can supplement control strategies discussed in Section A-2 and A-3. The 1977 Clean Water Act (P.L. 95-217) calls for more consideration of water conservation alternatives than has been given in prior water quality management planning and should provide an incentive for the active consideration of water conservation strategies.

The discussion in this section is limited to domestic water consumption; industrial water consumption has a different set of demand curves than individual households. While not explicitly considered in this section, many of the impacts discussed would also apply to large water-using institutions as hospitals, schools and group living quarters.

1.0 Control Strategies

There are literally hundreds of water-saving devices that are commercially available or will soon be available. A few generic types are listed below. Except where noted, most of these would be applicable to both preconstruction and existing development.

- Water-saving toilets which are similar to conventional types but which use up to 40% less water per flush
- Water-saving appliances, such as dishwashers, clothes washers, and showerheads
- Pressure-reducing valves which can be incorporated at the main service pipe in a house to reduce pressure for all household uses
- Non-water using toilets, such a compost toilets, oil recycling models, and incinerator toilets
- Correction of household plumbing leaks
- Water closet devices, such as plastic bottles, specially-fired bricks, or dams, which displace capacity in the water closet (primarily for retrofitting existing development)
- Faucet and showerhead inserts (primarily for retrofitting existing development)

2.0 Socioeconomic Impacts

There are four principal socioeconomic impact issues associated with domestic water conservation strategies: private firm (developer) costs for new development; individual costs/benefits; public expenditures/revenues; and public services demand. Each of these is briefly examined in Exhibit A-7.

342

Exhibit A-7

DOMESTIC WATER CONSERVATION: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	StructuralControl/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Private Firm Costs/Benefits (1) Changes in development costs[1]	(1) Amount and type of water-saving devices installed in new development will affect costs	(1) Regulatory requirements for performance of water-using appliances in new development will affect costs	
Public Services (1) Reduced consumption demands on water supply infrastructure[2] (2) Reduced wastewater flow demands on sewerage infrastructure[3]	(1),(2) Type and amount of fixtures installed or fixed in the household will affect amount of water savings[4]	(1),(2) Extent to which voluntary or mandatory techniques are used; extent to which public sponsorship or retrofitting devices is done for existing development; use and type of pricing mechanism[5]; extent to which strategies are geared to new development or existing development.[6]	
Public Fiscal (1) Changes in water and sewer revenues (2) Increases in regulatory and administrative costs (3) Costs associated with public retrofitting	(1) Type and amount of conservation fixtures used in the household will affect water savings and thus revenues derived from water use[7]	(1) Extent and type of pricing mechanisms used (2) Extent to which strategies are geared to new development (3) Extent to which retrofitting measures are publicly subsidized	(2) Extent to which regulatory and administration costs are financed by public funds or through permit fees
Individual Costs/Benefits (1) Changes water and sewer user costs (2) Increases in landscaping damage costs[8] (3) Increases in retrofitting costs	(1) Type and amount of fixtures used in the household will affect amount of water savings[9] and user costs (3) Type of retrofitting undertaken will affect capital costs	(1),(2),(3) Extent to which voluntary or mandatory techniques are used; use and type of pricing mechanisms[10]; extent to which strategies are geared to new development or existing development (3) Extent to which public sponsorship of retrofitting devices is done for existing development	

Exhibit A-7 (continued)

DOMESTIC WATER CONSERVATION

Indirect Impacts	Impact Stimulant	Discussion
Land Use/Housing (1) Increase in new housing costs	(1) Private firm (developer) costs	(1) This impact reflects the passing along of water conservation-related costs to new home buyers
Public Fiscal (1) Changes in capital and O&M costs for water supply and sewerage infrastructure	(1) Public services demand changes for water supply and public sewerage	(1) As discussed in note 2, the effects of water conservation strategies on water supply and sewerage infrastructure are dependent on many factors. Because of fixed costs associated with operating these infrastructure, small flow reductions may not affect O&M costs. Water conservation strategies may, however, favorably affect maximum day and peak demands or enable certain capital costs to be postponed.

3.0 Exhibit References

1. Developers are affected by pre-construction water conservation requirements. The costs of installing water-saving toilets and shower heads vary across the country. While they are generally cost competitive with conventional fixtures, they may represent additional costs to the developer. In any case, these additional costs are incidental in the context of overall housing costs. Furthermore, these costs will be passed along to the buyer.

2. The benefits of water conservation to the local water supply system are dependent, of course, on the existing demands on the system as well as the effectiveness of the conservation strategies. Theoretically, in systems where existing consumption demands are straining capacity, reductions in demand may postpone system investments. There may be little effect, however, in systems with substantial capacity. The most promising infrastructure benefit associated with water conservation is the reduction of seasonal peak demands. The latter require substantial capital investments in order to meet an infrequent need. Seasonal peak demand are flattened out, however, most effectively by outside water bans. These are general responses to crises situations rather than permanent behavior changes.

3. As in the case of water supply infrastructure, water conservation strategies may potentially reduce the demands on public sewerage facilities. The impact is dependent on the amount of flow reduction achieved, the number of homes using public sewerage facilities, and the capacity of the facilities relative to the flow reduction.

4. Toilet and shower flows represent about 75% of indoor water use. (See Milne, Murray, Residential Water Conservation, prepared for Office of Water Research and Technology, March, 1976.) Thus, conservation strategies that emphasize these fixtures will enable fairly significant flow reduction to occur. See also Cohen, J. and Wallman, H., "Demonstration of Flow Reduction From Households," U.S. Environmental Protection Agency, Environmental Protection Technology Series, National Environmental Research Center, Cincinnati, 1974.

5. Water is generally an inexpensive commodity and user charges associated with it generally represent only a small portion of household expenses. Therefore, small price increase are generally not successful in altering domestic water demand. Consumer responsiveness to price increases generally depends on price elasticity. Many water use studies have shown that consumption necessary for basic indoor uses is price inelastic, i.e., higher prices will have negligible effects on demand. Studies have also shown that the demand for water used outside the house is more elastic than the demand for water used inside the house. Seasonal peak demand rates if restrictive, can affect seasonal demands that result from more elastic outdoor water use. Socioeconomic status also affects demand--more affluent families use more water because of more appliances, pools, cars, and bigger lawns. (See

for example, Lupsha, P.A., et al., "Rain Dance Doesn't Work Here Anymore, or Water Use and Citizen Attitudes Towards Water Use in Alberquerque, New Mexico," University of New Mexico, Alberquerque, New Mexico, 1975; Aboot, E., et al., Social Aspects of Urban Water Conservation, Century Research Corporation, Arlington, VA., 1972; Linaweaver, R.P. and Howe, "The Impact of Price on Residential Water Demand and its Relation to System Design and Price Structure," Johns Hopkins University, 1967.)

In general price mechanisms may increase water conservation by reducing elastic uses, such as outdoor uses. Small changes in the price of water are not likely to cut into inelastic demand and induce consumers to change their behavior.

6. The effectiveness of conservation strategies is dependent on the amount of water demand desired to be affected. Strategies designed to affect primarily new housing development in relatively stable population areas will affect only a small portion of overall demand.

7. The decrease in water revenues brought about by water conservation strategies may not be favorably viewed in communities with high fixed costs. In particular, communities that have recently invested in improvements are looking for increased revenues to pay off the debt service charges.

8. Outside water bans may produce these costs.

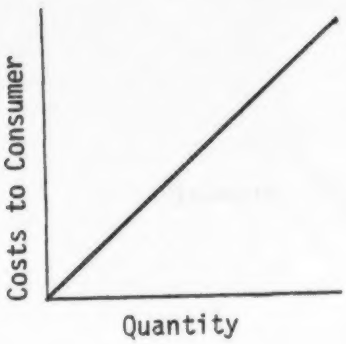
9. See also note 4. For homeowners with private on-site systems, flow reductions will generally benefit septic system maintenance costs. If the overall household waste volume is reduced, there will be a longer retention time for the wastewater in the septic tank. This will enable the septic tank to perform its basic function, i.e., the settling of solids, in a more efficient manner. This will reduce the chance of solids entering the leaching field (where leaching fields are used) and clogging the field and causing premature failure.

10. As discussed in note 5, water user costs represent a small percentage of family income. Thus, increased user costs will not represent a large cost incidence. For low income families, however, demand reduction savings may not offset price increases because their demand is relatively inelastic. The effect of different pricing mechanisms are shown in the following graphs:

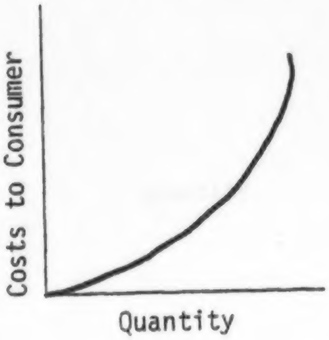
346

The decreasing block rate, widely used in this country, reduces the incentive for water conservation and benefits larger water users such as the affluent. The consumer under this scheme pays one price for a certain quantity of water and then pays a lower price for any water used beyond this quantity. Under the flat rate and increasing block rate, costs increase with quantity consumed and provide an incentive for conservation. The increasing block rate, however, is more equitable to poorer and fixed income consumers than the flat rate.

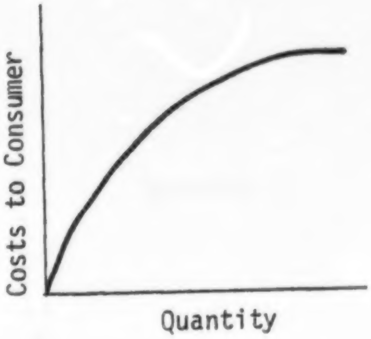
Flat Rate



Increasing Block Rate



Decreasing Block Rate



A-8 — URBAN STORMWATER SOURCE CONTROLS

For many urbanized and urbanizing areas, it may simply be impractical from a cost point of view to implement large-scale structural solutions for stormwater pollution. As discussed in A-10, there are also other important socioeconomic issues associated with end-of-the-line structural solutions. Source controls may represent very attractive alternatives to these structural controls--particularly in selective urbanized watersheds that have been identified as critical to water quality.

The purpose of source controls is to prevent pollutants from being washed from impervious surfaces into local waterways. Typical preventative approaches in stormwater management include:

- Removing surface pollutants before they are washed into the drainage system (e.g., street sweeping)
- Preventing precipitation from coming into contact with materials that could potentially be transformed into water pollutants (outside materials storage controls)
- Restriction on the use of certain items or materials that have water pollution potential (highway deicing management practices, lawn fertilizer controls)

1.0 Control Strategies

1.1 Street Sweeping

Most urbanized areas have some type of street sweeping program, but it is traditionally performed for aesthetic reasons. In order to direct street sweeping operations toward pollution abatement goals, some modifications in existing practices may be necessary:

- Use of more efficient street sweeping vehicles (e.g. vacuum type)
- More frequent sweeping intervals

1.2 Litter Control

In areas where there is considerable pedestrian activity, particularly commercial areas, more effective litter prevention represents a potentially attractive means of urban stormwater source control. In addition, restrictions on the storage and transport of refuse and other potential polluting materials, may be effective stormwater prevention measures. Alternatives include:

- More refuse disposal receptacles in high litter generation areas
- Restrictions on outside storage of materials
- Restrictions on the transport of debris, sand, and waste, in uncovered vehicles

1.3 Highway Deicing Controls

The use of salt for winter maintenance of highways and roads represents a traditional method for ensuring highway safety in snowbelt areas. Salt-related damage from the use of sodium chloride has come under increasing scrutiny.[1] The types of costs associated with salt damage include: contamination of public and private water supply wells; automobile corrosion; bridges and highway corrosion; vegetation damage. It is also apparent that high salt levels in drinking water pose risks for people who require low-salt diets because of hypertension, cardiac surgery, and pregnancy.[2]

In terms of water quality issues, highway runoff poses particular problems for groundwater. Surface waters rarely exceed 70-100 ppm of chloride because of dilution and fast-moving streams. A maximum safe limit of 250 ppm has been set by EPA.[3] Salt-laden runoff leaching into groundwater sources on the other hand experiences less dilution particularly if wells are adjacent to runoff sources.[4] Alternatives include:

- Installation of runoff retention basins adjacent to highways
- Replacement of and calibration of truck salt spreaders to achieve less salt use
- Reduction of the salt/sand ratio used in application

2.0 Socioeconomic Impacts

2.1 Street Sweeping Controls

Socioeconomic impacts for street sweeping controls are relatively limited and will in most cases be minor, particularly if applied in selective areas. The principal impact issue relates to public fiscal costs which may be capital, regulatory, and operational costs. The latter costs may be particularly important for strategies involving more frequent sweeping. These added costs may also be considered as costs for improved public service as there will be beneficial sensory and public health impacts associated with better street sweeping.

2.2 Litter Control

Compliance costs fall on both private individuals and the public agencies if all of the management practice alternatives are implemented. In addition, public fiscal costs will include some regulatory costs for monitoring private compliance. As in the case of street sweeping measures, there will also be beneficial sensory and public health impacts. In addition, these strategies may positively affect individual property values.

2.3 Highway Deicing Controls

The socioeconomic issues are potentially numerous for this strategy. One of the primary benefits of deicing strategies is the water quality/public health issue. Because this guidebook is assuming that water quality goals are achieved by each alternative for a water quality issue, public health benefits associated with reduced sodium chloride in drinking water will not be discussed here. (See references in notes 1 and 2 for public health impacts.) In any case, the other socioeconomic impacts associated with deicing controls are markedly different depending on the strategy. The "non-structural" approaches--reductions in salt--basically involve less public capital costs, with beneficial impacts in terms of bridge corrosion costs, roadway maintenance costs, and vegetation replacement costs. Detention basins, on the other hand, represent "end-of-the-pipe" structural solutions and may involve capital costs. The significant socioeconomic tradeoff between the structural and non-structual approaches involves public safety. The classic argument against reduced highway salting is that increased accidents will occur. While a few studies have looked at the issue, it has by no means been resolved.[6] Reliable statistical evidence to establish a causal relationship between salt and safety simply does not exist. What has been established is that proper driver education is necessary to supplement salt reduction policies to reduce highway accident risk. Some communities, for example, use warning signs to indicate salt-free stretches of highway. Other communities also attempt to minimize the accident issue by retaining normal salt application in "high risk" areas, such as curves, hills, and intersections.

3.0 References

1. See, for example, Abt Associates, An Economic Analysis of the Environmental Impact of Highway Deicing, prepared for U.S. Environmental Protection Agency, EPA-600/2-76-105, May 1976; Massachusetts Department of Public Works, "Environmental Impact Report: Snow and Ice Control Program," 1974; Terry, Robert D., Jr., Road Salt, Drinking Water and Safety: Improving Public Policy and Practices, Bollinger Publishing Co., 1974.

2. In addition to above, see also Dahl, Lewis K., "Salt and Hyptertension," American Journal of Clinical Nutrition, 25:231-244, 1972; Russell, Edward, M.D., "Sodium Imbalance in Drinking Water," Journal of the American Water Works Association, 62:2:102-105, 1970.

3. See EPA National Interim Primary Drinking Water Standards, 40 CFR 141.

4. Soils, particularly, clay soils absorb sodium fairly well; chlorides, however, tend to leach into groundwater more easily. Because groundwater moves so slowly, there is very little mixing action.

5. See Safe Drinking Water Act, P.L. 93-523, Section 1424.

6. Some studies that have examined the issue include the following: "Salt Deicing Cuts Accidents by 75% According to New 116-City Survey," *American City,* p. 19, 1973; Anderson, Robert C., "The Economics of Highway Safety," *Traffic Quarterly,* pp. 99-111, 1975. While the salt/safety issue has not been resolved, the courts have often found highway officials negligent for not applying adequate amounts of salt to provide safe driving conditions for motorists. See Abt Associates reference above.

A-9 URBAN STORMWATER FLOW ATTENUATION CONTROLS

The purpose of this water quality management strategy is to reduce the amount of stormwater runoff or to reduce the velocity of the stormwater runoff. Source controls, previously described, represent the first line of defense in stormwater management. Flow attenuation controls also represent a prevention-oriented method for stormwater management. By reducing the pollution and the quantity of stormwater runoff through source controls and flow attenuation controls, end-of-the-pipe approaches such as storage and treatment can be concommitantly scaled down.

1.0 Control Strategies

Flow attentuation controls can be used in two different ways: to supplement source controls and storage/treatment controls in already developed urbanized areas; or to serve as a preventative technique in newly-developing areas. When used as a preventative method in new development, a site plan and grading plan is normally developed to guide the overall development of the site. The planning strategy essentially involves minimizing the amount of impervious surface in a particular site. By minimizing impervious surfaces and maintaining as much natural vegetation as possible, more stormwater infiltrates into the groundwater on-site and less stormwater runoff is produced. To further minimize runoff from a site, detention ponds may also be incorporated into the site plan.

In existing urbanized areas, there may be several variations in stormwater detention. Because of space and topography constraints, it may be infeasible to construct detention ponds. Consequently, multiple use alternatives, such as parking lots and roof tops, may be used. The adaptation of these other uses may require very little construction but the extent to which these can be used may be considered prior to construction. After it is detained, the runoff may infiltrate on-site, if soil and hydrologic conditions permits, or it may be released to the off-site drainage network.

A more elaborate version of temporary storage and release--which detention ponds represent--are larger stormwater retention ponds, where runoff is collected from a very large site area creating permanent ponds. The stormwater gradually infiltrates into the ground or evaporates.

2.0 Socioeconomic Impacts

This category of controls is very similar to the Urban Erosion Controls category (see Section A-11) in terms of socioeconomic impacts. Controls applied to new development primarily involve increased compliance costs for developers and increased regulatory costs for public agencies. In addition to these direct impacts, the increased developer costs would likely be passed on to consumers of new development.

It is generally rare for structural stormwater controls to be applied retroactively to existing development, but in such cases individual costs would be an important socioeconomic issue. Unlike urban erosion controls which are generally temporary in nature, many structural stormwater controls may be permanent in nature. These controls, particularly those that are planned as large multi-purpose facilities, may stimulate a range of socioeconomic impacts similar to those associated with reservoir projects. Such impacts may include: sensory benefits associated with the aesthetic attributes of the water body; recreation benefits; and individual benefits in the form of real estate benefits for adjacent property owners.

3.0 Exhibit References

1. Unlike urban erosion control measures which generally represent additional costs of development for builders and developers, stormwater management measures may in fact decrease developer's overall site drainage costs by reducing pipe sizes and excessive pavement costs. Increased developer costs are not automatic. Also, in the case of large-scale recreation ponds in new development used for stormwater management, the developer's stormwater management costs may be offset by increased real estate values surrounding the pond.

2. In addition to the *compliance* costs imposed by regulations, new administrative requirements may result in development delay and additional developer costs.

3. Developments requiring complicated or extensive control measures will require more extensive plan review and inspection costs.

4. Size is the critical factor in this impact issue. Obviously, a large multiple-purpose stormwater detention lake will have potentially greater aesthetic appeal than a small detention pond where runoff evaporates.

5. The ability to "water harvest," as artificial recharge of stormwater runoff is sometimes called, is highly dependent on the water quality of the runoff and the filtering ability of the soil. In particular, the first flush of stormwater after a storm may be laden with solids, suspended solids, and heavy metals. Some areas like Los Angeles County, California, however, have been successfully using water spreading basins for over 60 years. Other areas where stormwater harvesting has been used include Long Island, New York; Fresno, California; and Orlando, Florida. In some of these areas, pretreatment of stormwater before it enters detention basins is required. For further information, see Poertner, H.G., *Practices in Detention of Urban Stormwater Runoff* (Special Report No. 43), American Public Works Association, 1974; Hittman Associates, Inc., *The Beneficial Uses of Stormwater*, prepared for the U.S. Environmental Protection Agency, January, 1973.

Exhibit A-9

URBAN STORMWATER FLOW ATTENUATION CONTROLS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Private Firm Costs (1) Increase in land development costs	(1) Site characteristics; amount of development; type and size of facility; amount of maintenance required[1]	(1) Regulatory requirements and procedures which dictate nature and extent of technical compliance costs and administrative costs;[2] performance levels which represent opportunity costs	(1) The number of agencies required to review a developer's plans; maintenance arrangements negotiated with a locality during the post-construction phase; extent to which developer fees and charges are used by public agencies to finance plan review and site inspection costs.
Land Use (1) Land pre-empted for new development; (2) Modification of uses in existing development	(1) Amount of land required for control measure; (2) Extent to which there is multiple use of existing development for stormwater management	(1), (2) Regulatory requirements for new and existing development; extent to which there are explicit provisions for density bonuses based on minimizing runoff	
Public Fiscal (1) Increase in administrative costs; (2) Increase in operational costs	(1) Type, size, and nature of control measures[3]	(1) The extent to which regulations rely on specification standards performance standards, or discretionary standards (see Chapter 2); (2) The nature and adequacy of any performance bond requirements	(1), (2) The number of administrative functions to be performed; the distribution of functions among public agencies and between the public and private sector; the extent of fees and charges used to offset public costs
Individual Costs/Benefits (1) Increase in compliance costs for control measures on existing development	(1) Site characteristics; type and size of control measures; amount of maintenance required	(1) The extent to which regulatory requirements impose compliance requirements on existing development; the use and extent of drainage fees imposed on existing property	

Exhibit A-9 (continued)

URBAN STORMWATER FLOW ATTENUATION CONTROLS

	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Public Health/Safety (1) Diseases associated with mosquito-breeding conditions in detention basins (2) Increased drowning hazards posed to small children posed by detention basins; (3) Increased downstream and localized flood protection benefits	(1),(2) The size and permanence of stormwater basins; the location of these facilities	(1),(2) Regulatory requirements for facilities maintenance; regulatory requirements for forcing and safety precautions	(1) Inspection and monitoring arrangements
Sensory (1) Visual nuisance; (2) visual enhancement; (3) odor nuisance	(1),(2) The size[4] and permanence of detention facilities; the location of these facilities; (2) the extent to which natural features and open space are used as control measures	(1),(2) The extent to which visual criteria are provided for in the design review; (1),(2),(3) The extent to which there are maintenance requirements	(1),(3) The extent to which there are adequate provisions for inspection and maintenance of facilities
Public Services (1) Increase or maintenance of groundwater supply sources by artificial recharge; (2) Reduction in downstream capital and maintenance requirements for municipal drainage facilities	(1),(2) Size and location of facility (1) Water quality characteristics of runoff[5]	(1) The extent to which regulations require groundwater recharge consideration in site design; extent to which detailed planning has been done for groundwater recharge; (2) Performance standards required for different developments	(1) Extent to which there is public operation and/or monitoring of stormwater supply entering recharge basins
Recreation (1) Increased opportunities for recreational opportunities	(1) Size and location of stormwater management pond[6]	(1) Extent to which regulations require recreational planning considerations in stormwater management	(1) Extent to whicn there is adequate operation and maintenance arrangements for the lake[7]

Exhibit A-9 (continued)

URBAN STORMWATER FLOW ATTENUATION CONTROLS

Indirect Impacts	Impact Stimulant	Discussion
Employment (1) Increase in construction-related employment; (2) Decrease in construction-related employment	(1),(2) Private firm costs	(1) To a minor extent, the imposition of stormwater management controls will stimulate small increases in employment by the developer; (2) The imposition of stormwater management control measures will represent increased costs for some developers that have to be carried until they can be passed on to consumers. These carrying costs, in combination with other developer requirements, may force small developers and builders out of business. (See Chapter 9.)
Private Firm Costs (1) Increase in land opportunity costs	(1) Land pre-empted for development by control measures	(1) The amount and location of land that is pre-empted by control measures will affect the extent of this opportunity cost for a developer. Unlike many erosion control measures which are temporary in nature, many flow attenuation controls are permanent in nature and involve a permanent pre-emption of land or a multiple use of existing development. To some extent, a developer may be able to offset these opportunity costs by negotiating density bonuses or transfer of development rights from the regulatory agencies
Land Use (1) Increase in development costs	(1) Private firm costs	(1) In most cases the costs imposed upon developers and builders will be passed along to consumers and be reflected in higher costs for housing and other developments (See Volume II, Section6.)
Population (1) Change in local population mix.	(1) Development costs	(1) This is a potentially higher order impact resulting from the previous land use impact. Higher housing costs in certain locations may potentially restrict the ability of low and moderate income groups to move into a community. Because of the number of variables affecting a regional housing market, however, this impact issue should be examined carefully
Individual Costs/Benefits (1) Increases in individual property values; (2) Decreases in individual property values	(1),(2) Sensory impacts; (1) public safety impacts arising out of flood potential	(1),(2) Property values for properties adjacent to stormwater facilities may be adversely or beneficially affected depending on the sensory impacts associated with the facility. If stormwater detention facilities relieve downstream flooding, affected downstream properties may benefit by increased values.[8]

6. A number of large residential developments have incorporated man-made recreational lakes into their design. In order to maintain sufficient water levels, however, they generally need supply sources in addition to intermittent stormwater--that is, an existing stream or groundwater sources.

7. Without adequate provisions for minimizing water quality degradation and sediment deposits in recreational lakes, the recreational attractiveness of these lakes may be severely diminished. Two of the most famous recreational lakes in the United States--Lake Anne in Reston, VA, and Lake Kittamaquandi in Columbia, MD--have suffered from severe sediment problems from upstream development.

8. The benefits associated with this indirect impact is a standard benefit associated with larger reservoir projects. Because of their much smaller scale, recreational lakes and stormwater detention basins will generally have smaller scale flood protection benefits. See, Reid, G.W., A Methodology for Assessment of Water Resources Development: A Competitive Evaluation Model for Water Resource Planning, Office of Water Resources Research Institute, July 1973; Dornbusch, David M. and Stephen M. Barrager, Benefits of Water Pollution Control on Property Values, prepared for the Environmental Protection Agency, August 1973.

A-10 URBAN STORMWATER STORAGE/TREATMENT FACILITIES

It will be impossible to eliminate all stormwater pollution strictly by source controls or flow attenuation controls. To avoid discharge of stormwater pollution from existing infrastructures into surface and groundwater, it will be necessary in some cases to develop end-of-the-pipe storage and treatment facilities. This category includes only controls involving separate stormwater systems. While the structural storage and treatment controls for separate stormwater systems are similar in some respects to those for combined sanitary/sewer systems, the institutional arrangements are likely to be different and this will affect many of the cost-related impacts.

1.0 Control Strategies

The structural options for storage of urban stormwater will basically consist of storage and treatment alternatives similar to those available for combined stormwater/sanitary waste systems.

- Flow Control - In-line devices, such as gates and inflatable dams, are used to regulate flow and provide in-line storage.
- Deep Underground Tunnel/Tank - More substantial storage capability is provided in this control.
- Surface Pond/Basin - These usually achieve the greatest storage capacity.
- Treatment Alternatives - Physical, biological, physical-chemical.

2.0 Socioeconomic Impacts

The socioeconomic impacts associated with urban stormwater storage/treatment facilities may be similar to those for stormwater detention facilities. This is particularly the case where the facilities are above ground. Unlike flow attenuation devices, however, which are generally implemented during new construction and which are financed by developers and builders, urban storage and treatment facilities are generally financed by public revenues to serve existing development.

Exhibit A-10 summarizes the principal socioeconomic impacts.

Exhibit A-10

URBAN STORMWATER STORAGE/TREATMENT FACILITIES: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Sensory (1) Visual and noise nuisances associated with construction (2) Visual conflict with existing natural setting (3) Increase in odor nuisances	(1) Length of construction period; type and size of facility[1] (2) Size and location of facility[2] (3) Extent to which above-ground facilities are operated and maintained properly	(2) Extent to which design criteria are incorporated into the plan review (3) Enforcement of operating procedures by regulatory authorities	
Public Helath/Safety (1) Increase in potential disease vectors associated with mosquitoes and rodents (2) Increase in downstream flood control protection	(1) Extent to which facilities are operated and maintained properly; extent of construction along river banks[3] (2) Size of facility	(1) Enforcement of operating procedures by regulatory authorities	
Public Services (1) Augmentation of water supply sources (2) Disruption of traffic	(1) Use of stormwater for groundwater recharge or prevention of saltwater intrusion. Location and size of facility; type of treatment provided (2) Length of construction; location of facility		
Land Use (1) Pre-emption of land	(1) Use of above ground facilities; size of facility		
Public Fiscal (1) Increase in capital and operational costs associated with the facilities	(1) Size and types of facility	(1) Costs affected by amount of outside cost sharing; compliance requirements of state and federal regulations	(1) Type of public financing used

Exhibit A-10 (continued)

URBAN STORMWATER STORAGE/TREATMENT FACILITIES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Employment (1) Changes in construction and operation employment opportunities associated with the treatment facility	(1) Size and type of facility		

Indirect Impacts	Impact Stimulant	Discussion
Individual Costs/Benefits (1) Changes in homeowner drainage fees or property taxes (2) Decrease in property value adjacent to above-ground facilities	(1) Public fiscal costs (2) Sensory impacts;public health impacts	(1) See Chapter 2 for a discussion of public financing mechanisms and effect on users and non-users. (2) The impact on land values due to sensory impacts and public health impacts is likely to be confined to a small area around the above ground facilities. This type of impact is, of course, highly dependent on the type of other uses in the area.
Land Use (1) Change in land uses adjacent to above ground facilities	(1) Sensory impacts; public health impacts	(1) The frequency and magnitude of sensory and public health impacts may disrupt existing neighboring land uses or they may alter proposed development in the impact area around the facility.
Public Fiscal (1) Loss of tax revenues (2) Changes in public service costs	(1) Loss of taxable land for above ground facilities (2) Public service impacts	(1) This loss could be particularly significant if it involves prime water front property. (2) Possible changes in public expenditures for water supply may produce this impact.

3.0 Exhibit References

1. Underground tunnels, for instance, will probably pose more construction-related impacts.

2. Underground alternatives will probably be less of a visual intrusion in the natural landscape.

3. Construction along river banks, particularly in urban areas, will also generally disturb rodent nests.

A-11 URBAN SOIL EROSION CONTROLS

This control strategy is primarily concerned with construction-related erosion that occurs at the site of new buildings, roads, transmission lines, and other development activities. While the principal focus in this discussion is with private sector development activities, major public construction projects, such as roads, dams, and reservoir construction, may also be subject to soil erosion controls. In these projects public expenditures become a significant socioeconomic issue. Agricultural activities that produce erosion are discussed in Section A-12.

Urban erosion control activities may have substantial interaction with stormwater flow attenuation controls. Erosion discharge controls, for example, such as sediment detention basins, may be used after construction is complete at stormwater detention facilities. Conversely, stormwater detention facilities will help to reduce off-site erosion that takes place on streambanks because of increased stormwater runoff velocities. In general, if both types of controls are applicable to a site under development, the two should be planned and regulated simultaneously. To the extent that growth management controls are used to protect critical areas, there may also be congruence between urban soil erosion control and growth management objectives.

1.0 Control Strategies

There are numerous sediment controls that have been developed in recent years to prevent construction-related soil erosion. Because many controls are simply variations of each other, only representative examples are listed in this discussion of socioeconomic impacts.

Source Controls:

- Modification of surface characteristics, such as temporary seeding, mulching, planting; use of jute or other materials
- Modification of topography, such as slope modification, contour furrowing, and terracing
- Modification of runoff by the use of diversion dikes or small on-site basins
- Staged development to minimize soil exposure in wet-weather months
- Construction activity restrictions to minimize removal of vegetation or proximity to critical areas (steep slopes, water bodies, etc.)

Discharge Controls:

- Off-site detention basins
- Sediment filters or traps
- Land set aside as buffer vegetation

2.0 Socioeconomic Impacts

The principal socioeconomic impacts associated with erosion control measures are private firm costs, that is, the compliance costs to developers and builders for implementing erosion controls. These costs, in turn, are likely to be reflected in higher housing and other development costs.

The other socioeconomic impact issue that will likely be pertinent with erosion controls is the cost to government administering erosion controls. These costs may include plan review. In essence, the development of an erosion control program for new development at the local level involves a tradeoff between ensuring the effectiveness of private erosion control measures and minimizing public expenditures for administering local erosion control programs.

Exhibit A-11 presents a summary of these and other potential socioeconomic impacts associated with urban erosion controls.

3.0 Exhibit References

1. The maintenance and replacement of the erosion control measures may represent a significant cost component. This is a labor intensive task and may require hauling costs for off-site disposal of sediment.

2. The developer's costs are particularly affected by the necessity to develop grading plans for the site and by the delays represented by increased plan review time.

3. Developments requiring complicated or extensive control measures will require more plan review and inspection costs.

4. There are two important issues here. The number of public administrative functions is clearly critical. If enforcement arrangements are voluntary or irregular, then inspection and monitoring costs will be negligible. Similarly, technical assistance may not be used. Secondly, the ability to "share" public administrative costs with agencies such as the District Soil Conservation Service will distribute these costs outside of the local tax jurisdiction.

Exhibit A-11

URBAN SOIL EROSION CONTROLS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control Characteristics	Implementation Measures	Institutional Arrangements
Private Firm Costs (1) Increase in land development costs	(1) Site characteristics; rate of construction; type and size of facility; amount of maintenance required[1]	(1) Regulatory requirements and procedures which dictate nature and extent of technical compliance costs and administrative costs;[2] performance bonds which represent opportunity costs; technical assistance that may help to reduce control costs	(1) The number of agencies required to review a developer's plans; maintenance arrangements negotiated with locality during the post-construction phase; extent to which developer fees and charges are used by public agencies to finance plan review and site inspection costs
Land Use (1) Land pre-empted for development	(1) Amount of land required for control measure	(1) Regulatory requirements	
Public Fiscal (1) Increase in administrative costs (2) Increase in operational costs	(1),(2) Type, size, and nature of control measures[3]	(1) The extent to which regulations rely on specification standards, performance standards, or discretionary standards. (2) The nature and adequacy of any performance bond agreements.	(1),(2) The number of administrative functions to be performed; the distribution of functions among public agencies and between the public and private sector;[4] the extent of fees and charges used to offset public costs
Public Health/Safety (1) Diseases associated with mosquito-breeding conditions in detention basins (2) Increased drowning to small children posed by detention basins	(1),(2) The size of detention basins; the permanence of these facilities; the location of these facilities	(1),(2) Regulatory requirements for facilities maintenance; regulatory requirements for fencing and other safety precautions	(1),(2) Inspection and monitoring arrangements

Exhibit A-11 (continued)

URBAN SOIL EROSION CONTROLS

Direct Impacts	Characteristics Affecting Impact		
	Structural Control Characteristics	Implementation Measures	Institutional Arrangements
Sensory (1) Visual nuisances (2) Visual enhancement (3) Odor nuisances	(1) The use and size of detention basins; the permanence of these facilities; the location of these facilities (2) The extent to which control measures preserve vegetation and provide for natural area buffer zones	(1),(2) The extent to which visual criteria are provided for in the design review (1),(2),(3) The extent to which there are maintenance requirements	(1),(3) The extent to which there are adequate revisions for inspection and maintanence of facilities

Indirect Impacts	Impact Stimulant	Discussion
Employment (1) Increase in construction-related employment (2) Decrease in construction-realted employment	(1),(2) Private firm costs	(1),(2) The imposition of erosion control requirements will increase private firm costs. For some firms capable of carrying these costs before they can be passed on, there may be small increases in employment to perform the new erosion control tasks. This increased employment is likely to be rare, however, as in most cases the developer will simply use existing employees to perform these tasks. The imposition of erosion control costs, in combination with other developer requirements, may, however, force small developers and builders out of business. (See Chapter 9.) This decrease in firms might result in local area loss in construction-related employment.
Private Firm Costs (1) Increase in land opportunity costs	(1) Land pre-empted for development by control measures	(1) The amount and location of land that is pre-empted by control measures will affect the extent of this opportunity cost for a developer. Because most erosion control measures are temporary in nature, this is not likely to be a significant component of the developer's added costs.
Land Use (1) Increase in development costs	(1) Private firm costs	(1) In most cases the developer and builder costs will simply be reflected in higher costs for housing and other development. (See Chapter 11.)

Exhibit A-11 (continued)

URBAN SOIL EROSION CONTROLS

Indirect Impacts	Impact Stimulant	Discussion
Population (1) Change in local population mix	(1) Development costs	(1) This is a higher order impact resulting from the previous land use impact. Higher housing costs in certain localities may potentially restrict the ability of new residents to move into a community. Because of the number of variables affecting a regional housing market, however, this impact issue should be explained carefully.

A-12 AGRICULTURAL SOURCE CONTROLS

Agricultural nonpoint source include a variety of agricultural activities that pose a threat to water quality. The principal ones included in this discussion are the following:

- soil erosion
- fertilizer runoff/seepage
- pesticide runoff/seepage
- livestock waste runoff/seepage

The physical actions that may be taken by farmers to reduce or prevent water quality problems may involve actual construction of structural controls or the implementation of different management practices. Management practices may simply be changing planting periods, changing crops, or changing the location of different activities on a farm.

1.0 Control Strategies

Control strategies for each of the agricultural water quality issues are discussed separately. Obviously, there are strong relationships, however, among the structural controls. For example, conservation tillage practices for erosion control may result in greater amounts of pests. This may require use of chemical pest controls. There may also, of course, be similar implementation measures and institutional arrangements for each of the agricultural water quality issues. It is clear, for example, that the Soil and Water Conservation District (SWCD) will have an important role in the institutional arrangements for each of the issues.

1.1 Erosion Control

There are scores of structural controls available for erosion control. A sampling of some of these is listed below.

- No-till Plant in Prior-crop Residues - This technique requires that planting be done in narrow slots opened by a fluted coulter or other device. Crop residues remain all year.
- Conservation Tillage Practice - A variation in conventional tilling would be to till the soil with noninversion devices, such as chisel-type or disc-type plows. Another practice would involve tilling in alternating rows; this is referred to as strip tillage.
- Winter Cover Crop - This practice, where possible, provides a vegetated surface to prevent erosion that is particularly severe in the spring runoff periods.
- Contouring - This technique allows excess runoff to be infiltrated and slows the velocity of runoff thus minimizing soil detachment. The technique is only effective in moderate slope areas.
- Terraces - These systems support contouring in steep slope and long slope areas and act as a backup control when contour capacities are exceeded.

- Discharge Controls - Other support mechanisms would include sediment traps and vegetation buffers that would capture sediment and thus minimize eroded soil from entering waterways.
- Change in Land Use - Restrict planting in highly erodible land and use less erodible areas more intensively.
- Crop Rotation - Alternate crops, such as hay, reduce soil loss in alternate years.

1.2 Pesticide Controls

In defining best management practices for controlling pesticides, areawide water quality planning will generally examine alternatives dealing with the amount, timing, and method of chemical application, such as the general types listed below:

- Use Alternative Chemicals - To a certain extent, chemicals for crops are interchangeable and those with lower toxicity can be used; in situations with minor erosion problems but with surface runoff problems, pesticides that are adsorbed by the soil can be used rather than more soluble ones.
- Apply Pesticides to Minimize Loss - When it is possible to incorporate the pesticide in the soil rather than to broadcast over the surface of the land, there is less likelihood of runoff loss. In those situations, such as cranberrying, where aerial spraying is often used, applications should be managed carefully particularly during windy weather periods, to avoid contaminating nearby areas.
- Eliminate Excessive Treatment - Sometimes pesticides are applied in too liberal amounts "just to be sure." This practice should be avoided, as well as the application of pesticides in areas where they are not necessary.
- Rotate Crops - Use crop varieties resistant to diseases and pests.

1.3 Fertilizer Control

Nutrients used in fertilizer operations, like pesticides, can be transferred from the land by leaching, runoff, and eroded soil. Thus, practices designed to curtail soil erosion will also benefit nutrient management. Listed below are a few generic control options:

- Avoid Excessive Application of Nutrients - To a certain extent soils tests will enable farmers to predict the amount of fertilizer necessary for their crops in a particular year.
- Apply Nutrients to Maximize Plant Absorption - In many cases nutrient loss to runoff and leaching can be avoided by timing applications according to time of year and climatic conditions.

- Use Animal Wastes - Because of the rising costs of fertilizers due to energy prices, smaller agricultural operations may be able to meet a large amount of the fertilizer needs by using available animal wastes. There are difficulties associated with this method -- particularly determining the amount of nitrogen that animal wastes are providing to crops.
- Use Crop Rotations and Winter Cover Crops - where possible, to control nutrient loss to waterways. In the former case, less nitrogen may be required and in the latter case nutrient uptake is provided during the winter and spring, helping to minimize nitrate leaching.

1.4 Livestock Waste Controls

Prior to the widespread use of chemical fertilizers, animal manure was a principal means for crop fertilization. With chemical fertilizers supplying almost 90% of present fertilizer needs in the country, there is an on-going problem of what to do with manure wastes. The problem can be discussed in terms of two separate issues: animal grazing practices and concentrated animal feedlots.

Animal Grazing Practices:

- Fencing to prevent grazing in areas susceptible to pollution in nearby waterways
- Special watering facilities to allow livestock access to drinking water without having to use critical nearby water resources

Concentrated Animal Feedlots:

- On-site treatment and disposal facilities, such as oxidation ditches and septic tanks
- On-site storage and land application for use as a fertilizer
- On-site storage and composting for use as a fertilizer
- On-site storage and transport to a regional treatment processing/disposal facility

2.0 Socioeconomic Impacts

The two primary local and areawide socioeconomic impact issues of interest for each of the above four areas are agricultural producer costs and public expenditures for regulatory/administrative costs and cost sharing. Within the agricultural cost incidence issue, there are two general concerns of farmers related to these water quality controls: reductions in crop yield/farm income and direct compliance costs for implementing best management practices. An additional concern which falls more into an implementation feasibility issue, is the perceived threat to agricultural autonomy that is represented by water quality concerns. The economic implications of these controls is complicated, as it is in any situation involving the imposition of external controls on a business production function, by the individual producer's cost structure and by the market for the producer's products. An agricultural producer's view of these water quality controls will depend on the investment value the farmer puts on the farm. If the land is being held to be sold for development, then the farmer will be anxious to maximize short-term profits. Longer-term farmers, on the other hand, may view water quality costs as a necessary investment for long-term productivity.

Public regulatory and administrative costs may be split among federal, state, and county agencies. Local or county costs will be higher, of course, in agriculturally-intensive areas. Exhibit A-12 summarizes potential socioeconomic impacts associated with agricultural controls.

3.0 Exhibit References

1. The farmer's total production cost includes such items as direct crop costs, land costs, and transportation costs. The imposition of pollution control measures may affect each one of these major cost items through capital expenditures and operation/maintenance expenditures. Direct crop costs are the most sensitive area for cost impacts. Because crop operations such as soil preparation, fertilization, planting, pest control, harvesting, storage, and transportation are so interrelated, however, it is difficult to absolutely predict cost increases. For example, a given alternative practice in fertilization may affect pest control requirements. Similarly, changes in crops may require additional labor and equipment. See also Control of Water Pollution from Cropland; Volume I: A Manual for Guideline Development, EPA-600/2-75-026a, U.S. Environmental Protection Agency, Washington, D.C., 1975; University of Illinois, Alternative Policies for Controlling Non-Point Agricultural Sources, prepared for U.S. Environmental Protection Agency, 1978.

2. The agricultural producer's farm income will be affected by crop yield changes resulting from alternative practices and by changes in market prices. Alternative production methods may reduce or increase crop yields. For example, reductions in fertilizer use may reduce expected crop yields. Similarly, loss of acreage will affect crop yields.

Market price may also affect crop revenues. Crop prices are affected, obviously, by the demand and structure of the market for outputs -- that is, the ability of farmers to pass cost increases along to consumers. Certain farmers may not be able to implement water quality controls as efficiently as other producers. In these cases market price increases may not be sufficient to offset increased production costs.

3. Increased production costs may be offset by federal cost sharing programs and by federal and state tax provisions. Not all control measures may be eligible for cost sharing depending on local Agricultural Stabilization and Conservation Service (ASCS) policies.

370

Exhibit A-12

AGRICULTURAL SOURCE CONTROLS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact: Structural Control/Management Practice Characteristics	Characteristics Affecting Impact: Implementation Measures	Characteristics Affecting Impact: Institutional Arrangements
Agricultural Producer Costs/Revenues (1) Changes in production costs[1] (2) Changes in crop income[2]	(1),(2) Amount, type, size, and mixture of required facilities; extent to which new production practices or required activities decrease crop yields	(1) Extent of regulatory procedures (1) Amount and type of subsidy[3] (1),(2) Extent of technical assistance available[4]	(1) The numbers of agencies involved in regulating the agricultural producer
Public Fiscal (1) Increases in regulatory and administrative costs (2) Increases in economic subsidy costs	(2)Non-structural controls will involve less economic subsidies	(1) Extent of regulatory and technical assistance activities (2) Amount of economic subsidies	(1) Distribution of regulatory and administrative responsibilities among public agencies; source of public financing[5]

Indirect Impacts	Impact Stimulant	Discussion
Agricultural Producer Costs/Revenues (1) Changes in land values	(1) Changes in production costs; changes in crop income	(1) The interaction between actions taken by affected and non-affected farmers may have significant implications for land values. For example, agricultural land that is highly erodible will result in higher production costs and/or less crop yield. Within a particular region, less erodible land may be expected to increase in value relative to more erodible land.
Land Use (1) Conversion of agricultural acreage to developed uses	(1) Increase in agricultural costs; reductions in crop yield	(1) Water quality controls may stimulate or reinforce a farmer's desire to sell all of his agricultural land--depends on the farmer's long-term view of his land. Even for some producers who desire to maintain long-term agricultural interests, it may be necessary to maintain economic viability by selling small parcels of land to developers.

371

Exhibit A-12 (continued) AGRICULTURAL SOURCE CONTROLS

Indirect Impacts	Impact Stimulant	Discussion
Employment (1) Reduction in direct farm employment (2) Reduction in farm support employment through multiplier effects	(1),(2) Agricultural producer costs/revenues	(1) The response to additional costs associated with water quality controls may be to simply go out of business. Such a response will produce a loss of farm employment. (2) Modified agricultural production methods or reduction in farm acreage will have a ripple effect through the business that supply farms with materials and equipment. This may result in indirect losses of employment for an area.

4.   Technical assistance may enable the producer to comply in the cheapest possible manner at the highest crop yield.

5.   Public costs for agricultural water quality controls -- both regulatory/administrative and economic subsidy payments -- are largely absorbed by federal and state programs. Certain additional technical assistance and administrative costs will be incurred by the Soil and Water Conservation District which generally derives a portion of its funding from local sources.

The use of mandatory versus voluntary plans will significantly affect public regulatory costs. For example, mandatory erosion control plans would require increased staffing at the local level to deal with technical assistance, plan review, and enforcement.

A-13 GROWTH MANAGEMENT CONTROLS

One of the principal focal points of water quality planning is the relationship between land use and water quality. The types of activities and their spatial distribution have some readily apparent impacts on the quality of water in an area. At the same time, strategies developed to improve and manage water quality may have significant effects on an area's traditional pattern of development. This section outlines generic approaches available to the planner for managing growth to promote improved water quality, and presents potential socioeconomic impacts that may result from the implementation of these strategies.

A variety of factors produce a land use pattern in a community. This pattern is characterized by four elements, each of which can in turn affect the social and economic fabric of the community:

- Amount of growth
- Location of growth
- Character of growth
- Timing of growth

Each of these land use elements can be controlled by growth management strategies, as they alter traditional development patterns and forces. Changes in these four elements in turn have the potential to alter the area's economic and social structure, as residents, businessmen, industrial workers and other members of the community bear costs and reap the benefits of various strategies.

1.0 Control Strategies

1.1 Descriptions of Local Jurisdictional Controls

ZONING CONTROLS

Since the early part of this century, zoning has been the basic tool for controlling the type, amount and location of new development in a community. Community ordinances typically specify the height, bulk, and density of new buildings. Zoning can be used to control the availability of land for various uses, and may impose specific limits on acceptable characteristics of these uses. These restrictions may prohibit a use from the community entirely, or may confine it to narrowly specified alternative locations.

Minimum lot sizes and other development standards aimed at limiting construction have also been incorporated into most zoning ordinances. A refusal to sewer may be used to justify zoning requirements for large (i.e., greater than one acre) lots in areas where on-site systems cannot perform adequately on smaller lots.

Several additional provisions of a modern zoning ordinance may also be employed as part of a water quality management strategy, providing a community with a flexibility not afforded by a reliance on minimum lot sizes to preserve environmental quality. These include:

- Cluster zoning, which establishes a minimum average quantity of land required for each dwelling unit in a development but does not limit specific lot sizes. Land that is not actually used for the construction of dwelling units is frequently used for conservation or recreation. This technique is often used to concentrate development on land that is capable of supporting it and to encourage the preservation of open space, while providing for at least as many dwelling units as would be permitted under traditional zoning.
- Planned unit developments (PUDs), which provide for the development of large tracts of land usually with a mix of residential types as well as commercial and/or industrial uses. Zoning ordinances enabling this type of development usually require a developer to submit detailed plans for a proposed development, and often require estimates of impacts. This is the most flexible type of zoning provision in that it establishes a negotiation process between the developer and a municipality, and permits the community to be very specific about appropriate uses in a particular development.
- Sensitive area zoning is directed at the preservation or conservation of land that is susceptible to environmental damage. Types of sensitive areas commonly include wetlands, floodplains, hillsides and areas susceptible to erosion, etc. This type of control is frequently implemented through the use of an overlay district which is not included on the community's zoning map but takes precedence in areas which meet certain criteria: for example, all land within 100 feet of a stream may be incorporated into an overlay floodplain district.
- Impact or performance zoning specifies standards for new development based upon its expected impacts on the community's public facilities, environment, etc. The most comprehensive of this type of control bases the standards upon an assessment of the carrying capacity of the community's land and infrastructure. A permit procedure may be established which allows a reviewing agency to monitor each step of the development process. Flexibility is provided by allowing bonuses (e.g., in density) where the developer provides benefits to the community. Less complex controls establish performance criteria for various uses, and may specify locations (as defined on a community's zoning map). These standards may deal with issues such as permissable emissions to air or water, traffic generation, etc.

375

DEVELOPMENT CHARGES

Two types of charges are commonly used by communities as a check on growth. Cash charges include building and other permit fees, connection charges for tap-ins to community water or sewer lines, and taxes on construction. Charges payable in-kind include subdivision requirements for the dedication of land and/or completed tangible improvements such as roads, parks, and the like.

DELINEATION OF URBAN SERVICE BOUNDARIES

This approach defines a maximum service area for the provision of facilities. Within this "urban service boundary," all urban development is allowed to locate where public facilities can be economically provided. Development at moderate and high densities is discouraged outside of the service area. Traditional land use tools are used both within and without the urban service boundary. Within the boundary, these are augmented by policies staging the provision of public facilities.

GROWTH MANAGEMENT TECHNIQUES

Although in a broad sense all strategies in this section fall into this category, techniques of concern here are those that emphasize controls on the timing of development. Many schemes also designate quantitative systems to aid the reviewing agency in evaluating specific development proposals. There are several types of techniques in this group:

- Wastewater Moratoria. These are usually of finite duration, and are often imposed as the result of emergency conditions in an existing sewerage system. Several types of moratoria are commonly found, including bans on permits for sewer taps, bans on new building permits, bans on permits for sewer extensions, and limits on subdivision approvals. These are often limited to residential construction. Moratoria are usually lifted as the required capacity becomes available in the area's sewerage system.
- Periodic Quotas. These are limits on the number of dwelling units for which building permits will be granted during a specified time period (e.g., Petaluma's ordinance limited residential construction to 500 dwelling units per year). At the end of the time period, the quota is reimposed (presumably, it may be reevaluated at this time). To limit growth, the quota must be set at a lower level than that reached by "natural" development pressures.
- Blanket Quotas. These are the outright ceilings on population established by referendum in Boca Raton, Florida and attempted in Boulder, Colorado. Once the permanent population level is reached, the number of dwelling units built will be equal to the number demolished during a given period. While this measure is usually discussed in terms of population ceilings, it probably can also be formulated in terms of the maximum number of dwelling units in a given area.

- Use of Capital Programming for Phased or Sequential Development. There are several tools available to ensure that growth follows the availability of public services. The more sophisticated approaches have used the point-based permit system developed in Ramapo, New York. In this system, development proposals are awarded points based upon their compliance with the town's goals, and objectives for the amount and location of growth, including the availability of public water and/or sewer services. Where services either do not exist or will not be in place by the completion of the development, Ramapo allows developers to provide these services. In other communities where similar plans have been adopted, the lack of public services means that developers cannot accrue enough points for a permit, as the private construction of these facilities is not allowed (e.g., Fairfax County, VA). In these communities, the capacity of the necessary public facilities acts as a ceiling on development. In other communities, development proposals are reviewed for their conformance with short-term capital plans as part of routine subdivision reviews; only development to be served by facilities included in an adopted capital improvement programis eligible for subdivision approval. Another approach requires consideration of staging development: under a "land withhold" clause, the developer agrees to leave specified parcels undeveloped until water and sewerage services are available or for five years (whichever comes first).

PUBLIC ACQUISITION OF LAND AVAILABLE FOR DEVELOPMENT

This is probably the surest method by which land can be protected from development. In general, these techniques provide a community with more latitude than traditional land use regulations. A community can use public acquisition to deny all economic development of the land, or to specify the exact types and timing of development that will be permitted. There are several methods that can be used to acquire land:

- Fee simple, in which a parcel is purchased outright by the community. Due to the high costs of land, it has primarily been used to acquire public park/conservation land and for urban renewal. Both purposes are heavily subsidized by the federal government.
- Land banking, where a community or non-profit group can purchase and develop land for a variety of future uses:
- Compensable regulation and/or purchase of development rights, which distinguish ownership of the land from ownership of the right to develop this land; and
- Acquisition by less than fee simple, particularly through the purchase or donation of conservation easements and restrictions, and other types of rights of way. These restrictions take the form of a legal agreement between a property owner and either a community or a non-profit organization specifying that a parcel will remain

in its natural state for a specific period of time (which may be in perpetuity). This method of foregoing rights to development provides tax benefits to the property owner and conservation benefits to the community. While not all restrictions or easements allow public access, in some cases the use of a parcel for a right-of-way may be included as part of the agreement.

1.2 Measures Imposed by States and Regions

REGIONAL OR STATE CRITICAL AREAS PROTECTION

Several states have enabled the designation of critical areas for protection. Florida, California and Hawaii are examples. Environmentally sensitive areas -- such a coastal zone areas, large wetland areas, aquifer recharge areas -- are formally designated as critical areas. There are a variety of ways that have been used thus far to regulate development in these areas. In some cases, only certain uses are regulated. Generally, a regional or state body has review of local development decisions in the critical area and in some cases veto power. This type of approach is attractive because water quality sensitive areas often extend beyond the boundaries of municipalities.

PREFERENTIAL TAX ASSESSMENT

Several states have enacted legislation that allows land used for specific purposes to be taxed according to its current use, rather than according to the use for which it is zoned. For example, farmland is frequently zoned for residential uses (originally this was done as a favor to farmers who could then obtain a higher price for their property when it was sold) and farmers pay higher taxes based on this more "intensive" use classification than they would if the land were zoned for agriculture. With preferential assessments, the farmer pays taxes on the land's fair market value as farmland; the farmer theoretically will not be as tempted to sell off his land for house lots if his costs are lower. Generally, preferential tax assessment programs include some type of penalty if the land is sold for another use; the landowner may be required to pay the differential between the taxes paid at the preferred rate and what would have been paid if the land were in the new use. This approach has been used to encourage the preservation of land being actively farmed, and forests that are being actively managed. In addition, preferential tax assessments are now being developed for land that is not actively used (i.e., privately owned conservation land) and for land that is currently used for recreation. These assessments are usually administered through the local tax assessor's office, and generally involve some indication from the landowner of income (or wood or other products) generated by the parcel or current non-income producing use (in the case of conservation land) to be eligible for the preferential assessment.

2.0 Socioeconomic Impacts

While growth management controls cut across all of the socioeconomic impact categories developed in this guidebook, the most significant issues center around land use effects -- particularly housing -- and secondary tax base and public service effects. Both potential direct and indirect impacts are listed in Exhibit A-13.

Exhibit A-13

GROWTH MANAGEMENT CONTROLS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

	Impacts Growth Management Control	Public Revenues/ Expenditures	Employment/ Economic Growth	Costs To Firms/ Developers	Costs/Benefits To Individuals	Land Use/ Housing	Public Services	Recreation	Historic/ Cultural Resources	Sensory Quality
ZONING CONTROLS	Restrictions On Uses	• may limit sources of public revenues (e.g., property sales taxes)	• where economic development is limited, future employment will also be limited • where residential development is limited, construction sector will be affected	• restrictions may make development more expensive • restrictions on economic development may limit expansion opportunities for existing firms	• where residential development is limited, value of older housing should rise • may increase tax burden for current residents	• restricted activities will have to locate elsewhere • change in traditional patterns of development	• expansion of pertinent facilities (sewers, water, transportation, schools, etc.) may not be necessary	• may open land for recreation		• where uses currently found in community are restricted, visual impacts can result
	Minimum Lot Sizes, Etc.	• (revenues) more costly housing may increase tax base • exclusion of groups needing services may reduce expenditures	• not usually affected, except as construction industry is affected	• development costs should increase (higher land) acquisition & improvement costs	• value of land increases • increase in total public costs/household	• decreases density • may decrease number of new housing units built • spread population increase over wider area	• costs per household may increase as population density decreases	• different types of facilities may be needed as larger lots allow for some types of recreation to take place at home	• does not necessarily allow for preservation of existing resources	• reduced density may alter visual identity of community • may encourage preservation of natural features that are visually important
	Cluster Zoning		• not usually affected except as construction industry is affected	• increase in planning costs (time & money) to developers		• allows for concentration of new housing where land can support it • encourage diversification of housing types	• may allow for more efficient services	• should preserve open space for recreation	• should allow for preservation of existing resources	• same as above
	PUD Ordinances	• may increase public revenues through addition to tax base	• where non-residential uses are included, employment opportunities will increase	• increases in planning costs (time & money) to developers		• allows a more efficient use of land • may encourage diversification of housing types	• may allow for more efficient provision of services	• community can insist on provision of open space and facilities	• should allow for preservation of existing resources	• architectural fit can be negotiated • may allow for control of noise, odors from non-residential uses
	Sensitive Area Zoning	• can decrease community's ratables	• not usually affected except as construction industry is affected		• value of land near designated area increases	• will reduce supply of vacant land acceptable for housing		• may provide land for passive recreation	• can allow for preservation of existing resources	• may encourage preservation of natural features that are visually important
	Impact/ Performance Zoning	• increase in expenditures to administer review process	• not usually affected except for potential short-term delays in processing applications	• increases in planning costs (time & money) to developers		• may reduce supply of land available for intensive uses (residential, commercial, industrial) & increase land available for passive uses	• may allow for more efficient provision of services	• may prevent over burdening of existing facilities	• should allow for preservation of existing resources	

Exhibit A-13 (continued) GROWTH MANAGEMENT CONTROLS

	Growth Management Control / Impact	Public Revenues/ Expenditures	Employment/ Economic Growth	Costs To Firms/ Developers	Costs/Benefits To Individuals	Land Use/ Housing	Public Services	Recreation	Historic/ Cultural Resources	Sensory Quality
	Development Charges	• increase in public revenues • potential increase in administrative expenditures to implement charges	• where building rates decrease, construction trades will be affected	• increase costs of development	• price of new housing will increase • value of old housing may increase slightly	• if charges are greater for one type of development over another, may alter housing characteristics or discourage some uses				• if charges encourage increase in density, may radically alter community identity
	Urban Service Boundaries	• allows for more efficient expenditures for public services • may reduce total public expenditures	• may limit economic activities in fringe areas		• increase real estate values in service area, decrease values at fringe • may raise price of new housing in service area	• should reduce development pressure on fringe areas • should reduce potential for leapfrogging • may increase densities within service area	• should allow for more efficient provision of services	• may increase land available for recreation in fringe areas • decrease land available within service area	• may encroach upon resources in service area where demand is high • may relieve pressure on fringe areas	
GROWTH MANAGEMENT CONTROLS	Moratoria	• postpone changes in debt characteristics, debt valuation ratio • decrease cost of administering land use controls	• where limited to residential development, impacts limited to construction sector (employment losses) • multiplier effect should decrease	• (developers) carrying costs for land • opportunity costs for capital invested in land	• may increase value of old housing • price of new housing will rise	• increase demand for old housing • new housing production increases before moratorium is imposed & after it is lifted	• should prevent emergency overload of existing systems	• may prevent short-term overload of facilities	• should allow for preservation of existing resources over short-term	• temporary impacts will reduce nuisances over short-term
	Periodic Quotas		• not usually affected, except as construction industry is affected	• (developers) carrying costs for land while waiting for permit • opportunity costs	• may increase value of older housing	• increases in growth before quota takes effect				• may preserve community identity or allow for gradual changes
	Blanket Quotas	• **increase costs of administering development process**	• not usually affected, except as construction industry is affected	• (developers) carrying costs while waiting for permit • opportunity costs	• increase price of new & used housing • increase taxes as costs of government rise	• increases in growth before it takes effect • number of dwelling units built will equal number demolished	• should eliminate need for expansion of existing systems except where per capita consumption of services rises		• existing resources can be preserved	• may act to preserve existing visual identity of community

Exhibit A-13 (continued)

GROWTH MANAGEMENT CONTROLS

Growth Management Controls	Impacts	Public Revenues/ Expenditures	Employment/ Economic Growth	Costs To Firms/ Developers	Costs/Benefits To Individuals	Land Use/ Housing	Public Services	Recreation	Historic/ Cultural Resources	Sensory Quality
GROWTH MANAGEMENT CONTROLS	Capital Programming For Phased Development	• increased expenditures to set up budgeting system	• fluctuations in construction trade should even out	• (developers) carrying costs for land that cannot be developed immediately	• may check rate of increase in tax burden/ household	• change in rate of growth	• should prevent emergency overloads • should allow for efficient expansion of existing systems		• allows for planning to enhance these resources	
PUBLIC ACQUISITION	Fee Simple Acquisition	• funds required to purchase land			• increase in taxes from increased public expenditures • value of houses adjacent to purchased area may increase	• will reduce supply of land available for development		• may provide additional land	• existing resources can be preserved	• can maintain existing community identity
	Land Banking	• where undertaken by a public entity, expenditures should increase		• private developers would compete with public or non-profit entity		• can reduce supply of land available for private development • can be used to further community housing goals		• can be used to provide additional land	• existing resources can be preserved	
	Transfer Of Development Rights	• administration costs of implementing and maintaining the program				• may shift location of new development				
	Conservation Easements	• potential loss of tax revenues on parcels • public funds if purchased			• may increase value of housing near restricted areas	• will reduce supply of land available for development		• may provide additional land	• can be used to protect land around resources	• may be used to maintain community identity
Limits On Demand			• not usually affected except where all demand is limited		• price of new housing for specific groups can increase • price of old housing can rise	• may create segmented housing market, e.g., elderly in new housing, everyone else in old housing		• different types of facilities may have to be provided for special groups		

Exhibit A-13 (continued)

GROWTH MANAGEMENT CONTROLS

Impacts / Growth Management Controls	Public Revenues/ Expenditures	Employment/ Economic Growth	Costs To Firms/ Developers	Costs/Benefits To Individuals	Land Use/ Housing	Public Services	Recreation	Historic/ Cultural Resources	Sensory Quality
Protection Of Critical Areas	• costs of administering a permit or plan review program • may increase state expenditures	• not usually affected, except as land for economic activities is limited	• increases developer's costs as permit procedures become more burdensome	• increases value of real estate adjacent to critical area • increases price of new housing as supply of land constricts • may increase state tax burden where implementation costs are high	• restriction of land available for some or all uses, at some or all densities			• existing resources may be protected	• can preserve natural resources that are visually important to state/community • can preserve important views, vistas
Preferential Assessments	• loss of tax revenues • costs of administering program	• not usually affected, except as supply of land for economic development is constrained	• increased tax burden on firms to compensate for service loss	• increased tax burden on individuals to compensate for revenue loss	• restricts supply of land available for development		• where recreation land or facilities are eligible, may encourage preservation of facilities	• may encourage preservation	• can preserve existing community identity

A-14 HYDROGRAPHIC MODIFICATIONS

This category of controls may supplement other categories. In essence, this type of control category represents the last line of defense in managing wastes. Rather than relying on waste generation reduction methods or treatment alternatives that modify a waste, this alternative is concerned with modifications in the assimilative capacity of the receiving water.

These types of controls are highly desirable in situations where low stream flows or extremely high waste loads make it impossible to achieve desired water quality goals even with the best practicable waste treatment technology. Through carefully planned hydrographic modifications, it may be possible to increase the assimilative capacity of a water body and, thereby, achieve desired water quality levels.

1.0 Control Strategies

It should be apparent by looking at the list of structural controls below that hydrographic controls primarily deal with dissolved oxygen water quality problems. There are three major ways of increasing the assimilative capacity for oxygen demanding wastes -- flow augmentation, artificial aeration techniques, and structural or channel modifications of the waterway. Artificial aeration techniques are primarily used in water impoundments, such as lakes and ponds.

- Augment flow, particularly in low-flow periods through inter-basin and intra-basin surface water transfers, groundwater pumping, or reservoir releases.
- Install mechanical in-stream aeration devices.
- Develop small dams/spillways in selected areas to achieve aeration.
- Realign channels to increase stream velocities where needed.
- Modify channels to increase hydraulic efficiency through channel lining or removal of natural obstructions.
- Install grade control measures, such as energy dissipaters, to decrease stream velocities where needed to minimize streambank erosion.
- Widen channels to decrease water depth to achieve better aeration.
- Harvest aquatic growth through compatible herbicides or by mechanical means.

384

2.0 Socioeconomic Impacts

The principal impacts associated with this control category include public costs and changes in recreation opportunities. As in the case of urban stormwater flow attenuation controls, the nature and magnitude of these socioeconomic impacts is highly influenced by the size and location of the structural controls. See Exhibit A-14 for a summary of the impacts.

3.0 Exhibit References

1. This is clearly a situation where the existing site characteristics will heavily influence the nature of the impact. In general, man-made alterations are more acceptable in urban, built environments and less enhancing in rural areas. Site specific conditions will dictate whether the man-made alteration is compatible with the surrounding landscape.

2. The diversion of water from one basin to another, unless carefully limited to certain amounts, could also result in profound effects. The loss of flows in one basin could lead, for example, to changes in recreational opportunities and sensory impacts (visual and odor).

3. Of particular concern are historic canals and archaeological remains adjacent to streambeds.

4. The magnitude of this impact will generally be small.

Exhibit A-14

HYDROGRAPHIC MODIFICATIONS: POTENTIAL SOCIOECONOMIC IMPACT ISSUES

Direct Impacts	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Public Services (1) Changes in the availability of water supply resources	(1) Extent to which inter- and intra-basin transfers of water resources are used		
Public Fiscal (1) Increases in capital and operational costs associated with facilities	(1) Size and extent of alterations	(1) Extent of federal and state cost sharing will affect local public costs	(1) Distribution of construction and operation costs will affect local, state, and federal costs
Sensory (1) Change in visual qualities of natural areas	(1) Extent to which man-made intrusions enhance or negatively alter the natural landscape[1]		
Recreation (1) Increased recreational opportunities where water impoundments are created by dams;(2) Decreased recreational opportunities for fishing, swimming, and boating due to such structural controls as in-stream aeration devices, dams, grade control measures[2]	(1) Size of the impoundment; (2) Extent to which alterations and modifications prevent or detract from existing recreational uses.		
Public Health/Safety (1) Increased flood protection benefits; (2) Improvement in conditions contributing to mosquito breeding	(1) Extent to which impoundments are used and reduce downstream flooding problems; (2) Extent to which flows velocities are increased by channel modifications		

Exhibit A-14 (continued)

HYDROGRAPHIC MODIFICATIONS

Direct Impact	Characteristics Affecting Impact		
	Structural Control/Management Practice Characteristics	Implementation Measures	Institutional Arrangements
Historic Resources (1) Changes in the number, type, use, or character of historic, archaeological, or architectural resources	(1) Sensitive to location and construction alterations[3]	(1) The use of federal funds will require adequate pre-construction assessment of historic resources	
Employment (1) Increase in construction related employment[4]	(1) Size and extent of alterations		

Indirect Impact	Impact Stimulant	Discussion
Individual Costs/Benefits (1) Changes in property values; (2) Increases in property taxes	(1) Sensory impacts; (1) Flood benefit impacts; (3) Public fiscal	(1) Property values for properties adjacent to hydrographic modifications may be adversely or beneficially affected depending on the sensory impacts associated with the alterations. If modifications relieve downstream flooding, affected downstream properties may benefit by increased values (see discussion for Urban Stormwater Flow Attenuation Controls). (2) The amount of local individual cost incidence will be affected by the type of financial mechanism used by the public agency to finance local costs (See Section 3).

APPENDIX B
Implementation Feasibility

B.1 INTRODUCTION

One of the important steps in strategy development is management or institutional planning. Essentially, management planning is the process of matching structural control needs with implementation measures and institutional arrangements. Choices have to be made concerning:

- The number of institutions to be involved;
- Their geographic and jurisdictional scope;
- The range of services to be coordinated;
- The allocation of functional responsibilities between the private and public sector and among levels of the public sector.

This process may be viewed as a step in institutional design, i.e., assessing the adequacy of existing institutions and measures and determing their "insitutional fit" or "compatibility" with water quality control needs. Compatibility has many dimensions, however, and this appendix attempts to define its components. For the purposes of this discussion, compatibility issues will be more explicitly discussed under the umbrella of implementation feasibility.

This guidebook has demonstrated that there are a number of distinct socioeconomic impacts associated with implementation measures and institutional arrangements. In particular, public revenue/expenditures impacts, cost incidence to firms, cost incidence to individuals, and public service impacts are prominent impacts. The guidebook has suggested that those socioeconomic impacts be considered along with the socioeconomic impacts of the structural aspects in the overall socioeconomic evaluation of a strategy. It is crucial to distinguish these "implementation impacts" from "implementation feasibility." Implementation impacts are the consequences of a water quality strategy; implementation feasibility, on the other hand, is a judgement of the likelihood of a water quality strategy being implemented. This judgement process or feasibility assessment is obviously a crucial one if water quality strategies are to be implemented. Attractive strategies may be designed that are cost effective and that minimize socioeconomic and environmental impacts, but if the solutions do not meet feasibility criteria, then there is a strong possibility that the strategy will not be implemented.

Implementation feasibility in water quality planning is not a well-researched concept with numerous studies that provide accepted definitional boundaries.[1] There is agreement, however, on implementation requirements for any particular planning strategy.

In general, the planner or planning agency has to examine the criteria listed below:

IMPLEMENTATION FEASIBILITY CRITERIA	ISSUES
• Legal Authority	Whether or not the implementation issues or institutional arrangements are legal.
• Administrative Capability	Whether there exists an agency or agencies capable of performing administrative responsibilities.
• Political Acceptability	Whether there is public support for the implementation scheme.

Each of the alternative water quality strategies should be assessed in light of these considerations. Section B.2 below discusses the legal authority. Administrative capability is reviewed in B.3. Political acceptability is discussed in Section B.4. Section B.5 suggests how these criteria may be used in the planning process.

B.2 LEGAL AUTHORITY

In proposing implementation measures and institutional arrangements for water quality strategies, two basic approaches may be used: the creation of new measures and agencies, or the alteration of existing implementation measures and institutions. For political acceptability reasons, as discussed below, the latter course has been a particularly attractive approach

384

in existing areawide water quality management planning. There are legal principles that shape the ability of the planning agency to adopt existing implementation measures and institutions to serve new purposes. These should be considered as "legal tests" in the modification of existing programs and in the creation of new ones. Some basic legal tests or legal authority criteria are briefly discussed below.[2]

Existence of adequate statutory authority or power

State, local and substate agencies are granted powers--either explicitly or implicitly--by enabling statutes, state constitutional provisions, or "home rule" authorizations. Implementation measures or additional responsibilities that exceed these powers do not meet this criteria and may be held to be invalid under judicial scrutiny. For water quality planning agencies, a legal opinion or careful review of case law may be required when matching powers with agencies. This issue is raised in water quality planning when new powers or functions are considered for grafting on to existing agencies. For example, other implementation considerations may clearly indicate the desirability of incorporating erosion control provisions in the local building code. A review of the state law enabling the local building code may indicate, however, this attempt to be beyond the authority of the local building code.

A more common legal authority problem in water quality planning is that encountered by the states in regulating nonpoint sources of pollution. The language of a state comprehensive water pollution control law may be couched in traditional point source pollution terms.[3] Without explicit authority for nonpoint pollution control, many state and areawide water quality agencies have reverted to the use of legislation specifically designed to regulate critical areas, such as flood plains, wetlands, or the coastal zone.

A third type of problem facing areawide water quality planners under this criterion is the pre-emption of local authority by state powers. Certain local authority, such as setting stream standards, is clearly preempted by long-standing state powers in this area. As states begin to legislatively enter the nonpoint source field in areas such as statewide sediment and erosion control, local authority in nonpoint matters may be circumscribed. For example, very few states with erosion control statutes delegate enforcement powers to local soil conservation districts. Planning agencies considering such an institutional arrangement may not only face strong political acceptability problems, but may be stymied by legal authority problems.

Legitimacy of purpose intended or served by implementation measure

Closely related to the above criteria is the problem of using traditional non-water quality measures to serve water quality goals. In water quality planning, two examples that fall into this category are requirements for water conserving toilets in local buildng codes and the use of local growth control measures for water quality purposes. In the latter case, for example, there is increasing recognition[4] of the legitimacy of large lot zoning as a method for ensuring adequate land for on-site systems and for water quality protection (using the traditional public health rationale). Where large lot zoning raises exclusionary zoning issues, however, the case law is mixed and thus water quality objectives may be overriden by the courts on a variety of constitutional grounds.[5]

Potential of the measure to violate equal protection rights, i.e., to be discriminatory, arbitrary, or unreasonable

In order to meet equal protection requirements of the Constitution, certain water quality control measures (particularly land use measures) have to avoid discrimination involving similarly situated landowners. Issues in water quality planning, for example, include stormwater requirements for new development. In general, the courts have held that new uses are not similarly situated as existing uses and normally uphold regulations which primarily apply to new uses.[6]

Extent to which water quality measures are confiscatory--involving a taking or a diminishing of private property values without just compensation

Many water quality implementation measures involve regulations that effectively prohibit the productive use of property. Examples include stormwater management, erosion, and growth management controls. The "taking" issue is a common one in pollution control litigation but one that courts have generally not used as a means for invalidating regulations.[7] The courts have granted a very liberal interpretation of cause-effect relationships in allowing controls that are designed to protect water quality.

B.3 ADMINISTRATIVE CAPABILITY

The administrative capability of a water quality strategy can be assessed using a variety of criteria.

Coordination with related services/institutions

This criterion involves the extent to which there are administrative or institutional connections between water quality management and related services and institutions. Such services may include water supply, solid waste management, land use, or recreation. Evidence of such capability may include past performance or explicit policies, plans, memoranda of understanding, or contracts.

Clarity of responsibilities and relationships

While the delegation of management responsibilities in particular water quality control strategies may often be lodged in one or two agencies, many strategies will often involve several agencies. This standard administrative criteria is concerned with the comprehensibility--both to the regulated and the agencies--of relationships among such agencies. The incremental growth of powers and responsibilities among agencies has frequently precluded this criteria from being met. This problem has prompted some states to institute "one-step shopping" for industries required to satisfy a myriad of environmental permit requirements.

Potential for voluntary compliance

In this criterion, strategies that induce self-compliance or voluntary compliance, are rated high. While it is difficult to develop strategies that meet this criterion in the purest sense, effluent surcharges that induce pollution control abatement actions on the part of industries may be considered a typical example.

Flexibility

Proposed institutional arrangements should possess a certain degree of flexibility along some parameters, particularly service area and functional responsibility. This capability will preclude the necessity for constant changes in institutional arrangements that may necessitate new legislative authority.

Adequate financial, manpower, and informational resources

The effectiveness of a water quality strategy will clearly be affected by the adequacy of resources to support designated responsibilities. For example, enforcement functions in water quality strategies are often compromised because of inadequate resources to do the job. If strategies are heavily dependent on functions that are unlikely to have adequate resources, then the strategy's effectiveness will be largely compromised.

Jurisdictional adequacy

Water quality problems clearly do not follow political boundaries. Yet, the difficulty in implementing watershed institutional arrangements often results in fragmented local institutional arrangements for solving areawide problems. A planning agency, for example, may convince one community to implement an erosion control ordinance while an upstream community remains recalcitrant. This type of situation is a clear example of conflict between the efficiency goal of internalizing water quality problems and political acceptability.

Overlapping responsibilities

In general, water quality implementation schemes should avoid duplicating services or functions currently being performed adequately by existing agencies or private sector groups.

B.4 POLITICAL ACCEPTABILITY

It would be highly presumptuous to set forth a checklist of absolute political criteria that could be considered universal in any water quality planning situation. Political acceptability is clearly a value-laden concept which cannot be as rigorously analyzed as legal and administratively feasibility issues. Often political acceptability criteria are inconsistent--they reflect conflicting perceptions of what is politically acceptable. Despite the inability to rigorously define a set of political criteria to be used in a given planning situation, there remains the need to incorporate political acceptability considerations into the decision making process. By examining the set of criteria discussed below, the water quality planner can reduce some of the uncertainty associated with speculative judgements about political acceptability. The criteria discussed below deal with issues above and beyond the political considerations tied to cost, effectiveness, and socioeconomic impacts. In general, those issues will dominate political acceptability concerns in the evaluation of water quality strategies. The issues described below, however, may be just as influential in certain areas and should be given consideration in plan evaluation.

Perceived Public Need

This criterion concerns the degree to which the problem being addressed is perceived as an important public need relative to other community or environmental needs. An urban soil erosion control strategy, for example, may involve a technically-sound approach for controlling sediment from new development in a community with little or no public fiscal costs. Unless the water quality impact of sediment, however, has been sufficiently dramatized, there may be no perceived need by the local implementing agency for such controls. In another type of situation, there may be a perceived need for a proposed water quality control involving the expenditures of public resources. In comparison, however, to a more pressing local need--a new water supply source, for example--the relative need may simply not be sufficient to make the water quality control politically acceptable.

Traditional Government Role

The extent to which the proposed implementation measures and institutional arrangements conform to local traditions and attitudes concerning government role may affect political acceptability. Innovative land use controls, such as Transfer of Development Rights (TDR's); public ownership of local septage pumping operations; restrictions on outside storage of materials--all may represent unacceptable extensions of local government in some communities.

Institutional Change

If proposed water quality control strategies require a substantial amount of institutional change within an agency or in relationships between agencies, then political acceptability problems may be encountered in the affected agencies. These changes may involve changed responsibilities for an agency (e.g., placing urban soil erosion control enforcement responsibilities under the jurisdiction of the building inspector) or they may shift the balance of power among agencies for a certain issue.

Expectation of Success

The political acceptability of a water quality strategy may be directly related to expectations on the likelihood of implementation. If the outcome of a strategy is uncertain or if the required implementation time is lengthy, agencies or the public may view the strategy as questionable. Less ambitious strategies but with more guarantees of success may be preferred to strategies that are untried or that have complex implementation procedures.

Decision-Making

The extent to which affected groups have access to and decision-making autonomy in institutional arrangements will influence the political acceptability of a strategy. One of the implications of this issue is the acceptability of regional sewerage arrangements and special districts. These arrangements may represent a loss of local power or create an additional hurdle for a local government in attempting to influence decision-making.

B.5 EVALUATION OF IMPLEMENTATION FEASIBILITY

Exhibit B-1 summarizes the three feasibility issues discussed and the criteria within each of three categories.

There are several ways of approaching the implementation feasibility issue. One approach would be to treat each of the criterion as attributes, similar to the socioeconomic impact categories, and to seek the "most feasible" alternative. This seems to be an inappropriate approach since the legal and administrative feasibility criteria have certain minimum standards that have to be met. The principal goal of the implementation feasibility analysis in this guidebook is to determine the feasible alternatives that should be considered in the final evaluation along with cost, socioeconomic impacts, and environmental impacts. Essentially the planner is required to screen out alternatives that are unacceptable in terms of implementation feasibility. The overall screening approach as perceived in this guidebook is to determine feasible and infeasible alternatives.

Because the political acceptability criteria are more judgemental than some of the other administrative capability criteria and the legal authority criteria, different types of screening tests would appear to be appropriate. It may be appropriate for example, to use a conjunctive screening method for the legal authority category. In this screening method, outcomes for each criterion for an alternative would be categorized as acceptable/unacceptable. The alternative would only pass the legal authority feasibility test if all of the outcomes registered acceptable.

Example B-1 EVALUATION OF IMPLEMENTATION FEASIBILITY

BACKGROUND:	*Water quality planning agency is proposing that water conservation strategies be used as one means to reduce sewage flows in the local municipal sewage treatment plant and thereby obviate the need for costly expansion. Specifically, the agency proposes an increasing block rate pricing scheme for all water users. After performing required research on the feasibility issue, the agency's evaluation of implementation feasibility is shown below.*		
FEASIBILITY CATEGORY	*LEGAL AUTHORITY*	*ADMINISTRATIVE CAPABILITY*	*POLITICAL ACCEPTABILITY*
FEASIBILITY TEST REQUIREMENTS	*All criteria must be categorized as acceptable.*	*Criteria AC-5 and AC-6 must be categorized as acceptable; aggregate sum of other criteria must total 15.*	*Aggregate sum of criteria must total 12.*
INDIVIDUAL CRITERIA RESULTS *(Y=acceptable, N=unacceptable for criteria that use categorization judgements; 0-5 interval measures used for criteria that require scoring measures, with 0 being least acceptable; NA=not applicable)*	*LA-1: Adequate Statutory Power (Y)* *LA-2: Legitimacy of Purpose (Y)* *LA-3: Equal Protection (Y)* *LA-4: Confiscation (Y)*	*AC-1: Coordination (5)* *AC-2: Clarity of Responsibilities (5)* *AC-3: Voluntary Compliance (3)* *AC-4: Flexibility (4)* *AC-5: Adequate Resources (Y)* *AC-6: Jurisdictional Adequacy (Y)* *AC-7: Duplication (5)*	*PA-1: Perceived Public Need (2)* *PA-2: Government Role (2)* *PA-3: Insititutional Change (4)* *PA-4: Expectation of Success (2)* *PA-5: Access to Decision-making (NA)*
CATEGORY RESULTS	*Acceptable*	*Acceptable*	*Unacceptable*
DISCUSSION:	*Because all of the feasibility categories must be acceptable, the alternative is rejected as infeasible and other water conservation alternatives are suggested for evaluation.*		

A variation on the conjunctive screening test might be appropriate for the administrative capability category. Alternatives would have to pass acceptability tests for certain specific criteria based on acceptable/unacceptable categorization. For the remaining criteria, judgements of feasibility would be assigned according to interval measures. The aggregate scores of the remaining criteria would be required to meet a certain minimum amount. For example, in order for an alternative to pass the administrative capability feasibility category, it may be required to be judged feasible on the resources and jurisdictional criteria *and* have an aggregate score of 15 on the remaining criteria (where feasibility scores of 0-5 are assigned to each of the criteria).

Because the political acceptability criteria are more difficult to measure, it may be appropriate to assign a feasibility score to each criterion and require a minimum aggregate sum for the category. A variation on this would be to weigh the individual criteria as well as to score them. Example B-1 presents an application of these techniques.

In order to measure or assess the feasibility of the respective criteria, several sources of information will be required. For the legal authority criteria, legal opinions may be solicited from the local solicitor, state attorney general's office, or the EPA regional counsel. This may be supplemented where possible by case law analysis. For the administrative capability criteria, interviews with the proposed institutions should be used by the water quality planner to assess each of the criteria.

Political acceptability judgements may require much more extensive research. There are essentially three types of approaches for making political feasibility assessments. The first approach requires a review of *secondary sources*, such as those listed below:

- *Newspaper articles* concerning water quality issues in the area, or previous related attempts to alter regulatory powers or institutional arrangements
- *Election results* or referenda concerning specific related issues or alterations in institutions in the area
- *Public hearing records* for similar proposals
- *Public agency meeting records* when similar proposals were on the agenda
- *Miscellaneous local government records* such as annual reports and budget profiles

While these types of retrospective inference techniques might be useful, they may not be indicative of current political feelings. It may be appropriate, therefore, to conduct *key informant interviews*. Key informants may include elected officials, public agency personnel, media representa-

Exhibit B-1

IMPLEMENTATION FEASIBILITY EVALUATION CRITERIA

Legal Authority

- Existence of adequate statutory authority or power
- Legitimacy of purpose intended to be served by implementation measure
- Potential of the measure to violate equal protection rights, i.e., to be discriminatory, arbitrary, or unreasonable
- Extent to which water quality measures are confiscatory--involving a taking or a diminishing of private property values without just compensation

Administrative Capability

- Coordination with related services/institutions
- Clarity of responsibilities and relationships
- Potential for voluntary compliance
- Flexibility
- Adequate financial, manpower, and informational resources
- Jurisdictional adequacy
- Overlapping/fragmented responsibilities

Political Acceptability

- The degree to which the problem being addressed is perceived as an important public need relative to other community or environmental needs
- The extent to which the implementation measures and institutions conform to local traditions and attitudes concerning government role
- Expectation of success--certainty of outcome; implementation time required; availability of outside funding
- The extent to which affected groups or local governments have access to decision-making and autonomy in institutional arrangements

tives, special interest groups, and business leaders. These individuals represent important sources of attitudinal data about political acceptability. Identification of key informants will vary with the water quality alternative. The citizens advisory group and the technical advisory group can be used to initially identify individuals. These individuals, in turn, can be asked to identify additional people to contact. Newspaper articles will also be an important source.

Finally, a more ambitious approach might involve the use of a public opinion survey. This approach could be done to randomly-selected households in an area where a strategy is to be implemented; or it might be done for a specific potential user group, such as households with on-site wastewater systems or households in a lake watershed area. Structured surveys have not been used to a great extent in the water quality planning under Section 201 or 208. While surveys can be viewed as an expensive means for gauging attitudes and public opinion, they may also be one of the best ways of getting opinions from the public at-large.[8] Surveys that are short and focus on specific issues and/or water quality strategies will have a higher response rate than broad, general surveys about water quality. In order to reduce one of the largest expenses associated with surveys, namely the distribution of them, several low-cost techniques are listed below:

SURVEY DISTRIBUTION TECHNIQUES	COMMENTS
• Mail out with water bill or sewer bill	Low cost technique; can be geared to specific zip codes; difficult to enclose a return franked envelope, however, which enhances response rate
• Newspaper advertisements	Can be geared to local or areawide paper which will determine cost; require respondent to assume return postage
• Door-to-door distribution	Using volunteer labor can be very inexpensive; best suited for specific neighborhoods or areas around a water body; easy to include a return franked envelope
• Phone survey	Can be time-consuming; good sampling design required; volunteer labor can reduce cost

B.6 REFERENCES

1. See, however, the following: Allen Kneese and Blair Bower, *Managing Water Quality: Economics, Technology, and Institutions*, Johns Hopkins Press, 1968; Marc Roberts, "Organizing Water Pollution Control: The Scope and Structure of River Basin Authorities," *Public Policy*, Winter 1971; Paul Hughes, *An Analysis of Alternative Institutional Arrangements for Implementing an Integral Water Supply and Waste Management Program in he Washington Metropolitan Area*, Institute for Defense Analyses, March 1971; David Ranney, *Water Quality Management: An Analysis of Institutional Patterns*, University of Wisconsin Press, 1972. For a more recent guidebook on institutional issues for selective areawide water quality issues, see Edward I. Selig and Eve Endicott, "Legal and Institutional Approaches to Water Quality Planning and Implementation," prepared for Environmental Protection Agency, 1977.

2. See Selig *et al*. for a more thorough discussion of the legal issues raised by water quality strategies.

3. See Aspen Systems Corporation, *Compilation of Federal, State, and Local Laws Controlling Nonpoint Pollutants*, prepared for EPA, 1975.

4. See for example, A. Strong and J. Keene, *Environmental Protection through Public and Private Development Controls*, prepared for EPA, 1974.

5. See Selig, *et al*., p. III-6.

6. See Selig, *et al*., p. II-15.

7. See Selig, *et al*., p. II-17.

8. According to a recent GAO report, "Water Quality Management Planning Is Not Comprehensive and May Not Be Effective For Many Years," CED-78-167, December 11, 1978, the lack of input from the public-at-large is one of the problems in implementing 208 plans. According to the report, "EPA's suggested methods for public participation--newsletters, briefings, media coverage, and questionnaires--only guarantee that those special interest groups or a few citizens who are interested would participate during formulation of the plan." (p. 29)

APPENDIX C

Financial Screening Procedure

Worksheets and Instructions for a Screening Procedure for Water Pollution Control Projects

DETERMINATION OF DEBT CAPACITY OF COMMUNITIES AND CITIES

prepared by

The Municipal Finance Officers Association
and Peat, Marwick, Mitchell & Co.
EPA Contract No. 68-01-4343

5/7/79

BACKGROUND AND PURPOSE OF THE SCREENING PROCEDURE

In recent years several communities in the United States have initiated water pollution control projects that have resulted in excessive costs to its residents. In some communities the increased sewage charges have resulted in residents leaving the community, refusing to pay sewage charges, or being unable to pay the charges. This creates hardships and in some cases leaves municipalities with insufficient funds to cover operating expenses and debt service payments.

The purpose of this screening procedure is to give the community and reviewing authorities a tool for analyzing a proposed project in its development stage to determine if the community can afford the proposed project.

Many 201 water pollution control projects are managed by special sanitary districts and authorities which include several communities. Because of overlapping boundaries, it is often difficult to identify a community's share of the project's debt and operating expenses. However, if a community identifies its share of the project early in the project's development (during step 1 of the EPA grant process) it can perform an analysis to determine if it can afford its share of the project's cost.

The attached worksheets are intended to give community officials and reviewing authorities a basis for reviewing the financial impact of the project on the community.

INSTRUCTIONS FOR COMPLETING THE SCREENING FORM

The form is divided into three parts:

Part I: Identification of the community's share of the proposed project.

Part II: Development of the community's financial characteristics and capacity (with and without the project).

Part III: Analysis of the ability of the community to support the proposed project given the community's financial characteristics and capacity.

Completion of each part of the worksheets may require data from the project engineer, the managing pollution-control agency, the community's finance director, local bankers, and financial advisors to the community. (See Attachment "A" for a description of Sources of Information.)

PART I

IDENTIFICATION OF THE COMMUNITY'S SHARE OF THE PROPOSED PROJECT

INSTRUCTIONS

Part I provides a worksheet for determining the total capital and annual costs for the proposed project. Sections 1 and 2 provide an analysis of capital costs with the new project and item 2i converts the local share of capital costs into an annual debt service charge (the repayment of principal and payment of interest).

Section 3 allows you to calculate total annual costs for the project, combining the amounts needed for operations, debt service, and any needed reserves. It should be calculated on the basis of when the proposed project starts full operations.

Section 4 is provided to help determine the community's share of annual total project costs if it is part of an overlapping district or authority. This will be based on a percentage allocation of costs agreement between the managing agency and your community.

Section 5 calculates the community's sewer charge for residential units with the proposed system.

Section 6 provides the same information with the existing system (without the proposed project). Be careful to show changes in the industrial share of costs and the number of residential unit served if these are to change with the proposed project. Try to use the most recent data available for the present system to reduce the error due to different time periods, since projects may take two to three years or longer to complete.

PART I

WATER POLLUTION CONTROL PROJECT ANALYSIS WORKSHEET

Identification of a community's share of the proposed project (to be completed by the community or the sewage managing agency).

TOTAL

1. Total Capital Cost of Proposed Project
    - a. treatment plant or individual systems ______
    - b. interceptor ______
    - c. collection system ______
    - d. total cost (a + b + c) ______
2. Capital Cost Analysis for Proposed Project
    - a. total cost ______
    - b. costs ineligible for EPA construction grant funds ______
    - c. costs eligible for EPA grant funds ______
    - d. EPA share (@____%) ______
    - e. state share (@____%) ______
    - f. local share of eligible costs ______
    - g. local share of ineligible costs ______
    - h. total local share (f + g) ______
    - i. total annual local share of capital costs (use a 20-year period for loan or bond maturity at estimated interest) ______
3. Annual Project Costs (when project starts operation)
    - a. operating and maintenance cost ______
    - b. debt service (2i above) ______
    - c. any required reserves (such as for industrial cost recovery) ______
    - d. total annual costs (a + b + c) ______
4. Community's Share of Annual Costs of New Project (if a multi-community project)[1]
    - a. annual O&M costs (@____% of 3a) ______
    - b. annual debt service (@____% of 3b) ______
    - c. annual reserves requirement (@____% of 3c) ______
    - d. total (4a + 4b + 4c) ______
5. Community's Sewer Charges for Proposed Project
    - a. total annual cost for the project (4d) ______
    - b. industry share of annual cost ______
    - c. residential share of annual costs ______
    - d. number of users served ______
    - e. annual charge per user (5c/5d) ______
6. Community's Present Sewer Charges
    - a. present total annual cost ______
    - b. industry share of present annual cost ______
    - c. residential share of annual costs ______
    - d. number of users served ______
    - e. annual charge per user (6c/6d) ______
7. Community's Total Sewer Charges (present plus proposed project)
    - a. total annual cost (5c + 6c) ______
    - b. total annual charge per user (5e + 6e) ______

---

[1] For single community projects the percentages in this Section would all be 100%.

PART II

DEVELOPMENT OF THE COMMUNITY'S FINANCIAL CHARACTERISTICS

INSTRUCTIONS

Part II provides a format for calculating key ratios that you can use to measure the community's ability to pay for the proposed sewer project. It is largely based on the types of measures used by credit analysts to determine a community's ability to repay debt. It is useful here because most communities borrow their share of sewer project costs and because the ability to pay for a project is of major concern to lenders.

The table is set up so that two major types of local financing can be analyzed: use of the tax-supported (general obligation) bond of the user-charge (revenue) bond. If the community plans to borrow for its share using a general obligation bond, fill out Part II G.O. (page 5). If the community will use a revenue bond, fill out Part II REV. (page 6). If you are uncertain as to which type of debt will be used to finance the local share, check with the finance officer or local financial adviser. You should enter the appropriate numbers for the most recent year, both without the project and assuming the project goes ahead. For example, were the community to do the project, the added debt and other costs you incur will be included in the figures in the column labeled "With the Project."

Several sources of information may be needed to get the figures used in Part II. (See Attachment "A" Sources of Information.) Figures relating to debt, taxable property value, current expenditures, property taxes and collections, and sewer operations and charges (where relevant) should be obtainable from the municipal finance officer and/or the sewer department or sanitary district. Information on population and income may be gotten from the municipal planning department, engineering consultant preparing the project, local economic development agency, or the U.S. Census. In all cases, attempt to use the most recent numbers available. Be prepared to make estimates of some recent values so that all numbers are for the same period, if at all possible.

G.O.

PART II GENERAL OBLIGATION
WATER POLLUTION CONTROL PROJECT ANALYSIS WORKSHEET

Development of the Community's Financial Characteristics (with and without the project)

	Financial Characteristics[1]	Without the Project Value	Without the Project Ratio	With the Project Value	With the Project Ratio
I.	Population Change (annual rate of growth for the last 5-10 years) % change				
II.	Net Direct Debt/Full Taxable Market Value				
A.	Net Direct Debt				
1.	general obligation (tax supported) debt				
2.	other direct (non-tax-supported) debt				
3.	gross direct debt (1+2)				
4.	offsets and deductions (self-supporting)				
5.	net direct debt (3-4)				
B.	Full Taxable Market Value of Real Estate				
III.	Overall Local Debt/Full Taxable Market Value				
A.	Overall Local Debt				
1.	net direct debt (from above)				
2.	overlapping (net) debt				
3.	overall local debt (1+2)				
B.	Full Taxable Market Value of Real Estate				
IV.	Net Direct Debt/Personal Income				
A.	Net Direct Debt (from above)				
B.	Total Personal Income of Community				
V.	Overall Local Debt/Personal Income				
A.	Overall Local Debt (from above)				
B.	Total Personal Income of Community				
VI.	Surplus/Total Current Expenditures				
A.	Operating Surplus				
1.	total current revenue				
2.	total current expenditures				
3.	operating surplus (1-2)				
B.	Total Current Expenditures				
VII.	Overall Local Property Tax/Full Market Value				
A.	Overall Local Property Tax (current year)				
B.	Full Taxable Market Value (from above)				
VIII.	Property Tax Collection Rate				
A.	Property Tax Collections (current year)				
B.	Property Tax Levy (current year)				
IX.	Annual Sewer Charge/Median Household Income				
A.	Annual Sewage Charge (from section 6e and 7b of Part I Worksheet)				
B.	Median Household Income				
X.	Bond Rating (outstanding bonds of jurisdiction)				
XI.	Percent of Long-Term Debt Due in Five Years				
A.	Debt Due in Five Years				
B.	Outstanding Direct Debt				

---

[1] Typical sources of data and a glossary of terms are appended to these worksheets as Attachment "A" and "B".

REV.

PART II REVENUE BOND

WATER POLLUTION CONTROL PROJECT ANALYSIS WORKSHEET

Development of the Community's Financial Characteristics (with and without the project)

Financial Characteristics[1]	Without the Project Value	Without the Project Ratio	With the Project Value	With the Project Ratio
I. Population Change (annual rate of growth for the last 5-10 years) % change		___		___
II. Overall Local Debt/Personal Income				
A. Overall Local Debt (from above)	___	___	___	___
B. Total Personal Income of Community	___		___	
III. Overall Local Debt/Full Taxable Market Value				
A. Overall Local Debt				
1. net direct debt	___		___	
2. overlapping (net) debt	___		___	
3. overall local debt (1+2)	___	___	___	___
B. Full Taxable Market Value of Real Estate	___		___	
IV. Annual Sewer Charge/Median Household Income				
A. Annual Sewage Charge (from section 6e and 7b of Part I Worksheet)	___	___	___	___
B. Median Household Income	___		___	
V. Net Sewer Operating Fund Income/Debt Service				
A. Net Operating Income				
1. operating revenue	___		___	
2. operating and maintenance expenses	___		___	
3. net operating income (1-2)	___	___	___	___
B. Debt Service	___		___	
VI. Rating (outstanding bonds of jurisdiction)		___		___
VII. Percent of Long-Term Debt Due in Five Years				
A. Debt Due in Five Years	___	___	___	___
B. Outstanding Direct Debt	___		___	

---

[1] Typical sources of data and a glossary of terms are appended to these worksheets as Attachments "A" and "B."

PART III

ANALYSIS OF THE COMMUNITY'S ABILITY TO SUPPORT THE PROJECT

INSTRUCTIONS

Part III presents the key items that lend themselves to quantification and the establishment of general characteristics of the strength and weakness of a community's financial ability. The analysis is constructed so as to indicate the values that will tend to be associated with strong credit quality and weak credit quality.

The worksheet in Part III is designed to help you compare a community's key ratio values as calculated on Part II with the "weak" and "strong" values for that characteristic. You should enter the ratios as calculated in the with the project column of Part II, in order to see how the project will affect the community's ratios if the project is done. (However, it may also be helpful to review the ratio values without the project in order to determine the degree to which the ratios are influenced by doing the project.)

Depending on the characteristic in question, values for the with the project analysis lying to the left of the "strong" value (or the right of the "weak" value) given will be considered as strong or weak in that characteristic. Values lying between the two values will be seen as not being necessarily strong or weak, but most likely "average".

G.O.

PART III
GENERAL OBLIGATION BONDS

RATIO:	QUALITY CHARACTERISTICS	COMMUNITY'S RATIO OR VALUE[1]	CHECK WHERE YOUR VALUE FALLS:[3] STRONG	IN BETWEEN	WEAK
I	Population Change (annual rate for next 5 to 10 years)	____	Above 1% ____	1 to -1% ____	Below -1% ____
II	Net Direct Debt/Full Market Value of Taxable Property	____	Below 2% ____	2 to 6% ____	Above 6% ____
III	Overall Local Debt/Full Market Value of Taxable Property	____	Below 4% ____	4 to 8% ____	Above 8% ____
IV	Net Direct Debt/Personal Income	____	Below 5% ____	5 to 15% ____	Above 15% ____
V	Overall Local Debt/Personal Income	____	Below 10% ____	10 to 20% ____	Above 20% ____
VI	Operating Surplus/Total Current Expenditures[2]	____	Above 5% ____	5 to 0% ____	Below 0% ____
VII	Overall Local Property Tax Rate/Full Market Value	____	Below 2% ____	2 to 5% ____	Above 5% ____
VIII	Property Tax Collection Rate	____	Above 98% ____	98 to 96% ____	Below 96% ____
IX	Annual Sewer Charge/Median Family Income	____	Below 1% ____	1 to 2% ____	Above 2% ____
X	Rating (Outstanding Bonds of Jurisdiction)	____	Aa or Above ____	A ____	Baa or Below ____
XI	Percent of Debt Due in 5 Years	____	Above 30% ____	30 to 10% ____	Below 10% ____
	TOTAL CHECKS		____	____	____

---

[1] Ratios and Values with the project from page 5 for General Obligation.

[2] Please indicate if there is a liability for payments to a pension program and the current status of those payments.

[3] The values shown form extreme parameters beyond which a particular credit characteristic value would in most cases be seen as "weak" or "strong." These values are subject to high degrees of local and regional variation.

REV.

PART III

REVENUE BONDS

RATIO:	QUALITY CHARACTERISTICS	COMMUNITY'S RATIO OR VALUE[1]	CHECK WHERE YOUR VALUE FALLS:[2]		
			STRONG	IN BETWEEN	WEAK
I	Population Change	____	Above 1% ____	1 to 1% ____	Below -1% ____
II	Overall Local Debt/Personal Income	____	Below 10% ____	10 to 20% ____	Above 20% ____
III	Overall Local Debt/Full Taxable Market Value	____	Below 4% ____	4 to 8% ____	Above 8% ____
IV	Annual Sewer Charge/Median Family Income	____	Below 1% ____	1 to 2% ____	Above 2% ____
V	Net Sewer Fund Operating Income/Debt Service	____	Above 200% ____	200 to 110% ____	Below 110% ____
VI	Rating — (Outstanding Bonds of Jurisdiction)	____	Aa or Above ____	A ____	Baa or Below ____
VII	Percent of Long-term Debt Due in Five Years	____	Above 30% ____	30% to 10% ____	Below 10% ____
	TOTAL CHECKS		____	____	____

---

[1] Ratios and Values with the project from page 6.

[2] The values shown form extreme parameters beyond which a particular credit characteristic value would in most cases be seen as "weak" or "strong". These values are subject to high degrees of local and regional variation.

Three important considerations must be underscored:

(1) The values of characteristics shown are subject to regional variations. Certain characteristic values that might have been seen as "average" in some areas would be considered as "strong" or "weak" in other settings. The intervals between the two benchmarks are broad enough to overcome most of this problem, but attention must be given to local and regional situations.

(2) Weakness in some characteristics may be offset by strengths in others, or there may be special circumstances. What must be looked for is a systematic pattern — a syndrome — of weaknesses or strengths.

(3) The quantitative analysis is no better than the basic data used to develop the ratios. Collection of reliable and up-to-date data can be difficult and estimates may have to be used to fill in the gaps.

Reviewing the twelve items in part II, 11 characteristics relate to general obligation debt analysis and 7 are typically of use in revenue bond analysis. Of these, when any three or more exhibit a "weak" value, evidence trends toward "weak" values, or where several cluster in the vicinity of "weak" values, the community can be expected to have or to anticipate difficulties in supporting the proposed project. Of course, many additional problem areas might surface in the course of an examination and these need to be weighed in consideration.

Communities that determine that a proposed project will result in excessive burden to its residents should:

- Review the adequacy and accuracy of the cost-effective analysis, particularly noting whether all the feasible alternatives have been considered and if the cost estimates are reasonable.

- Review the method of financing the local share and whether all the sources of supplemental funding such as the following had been sought out.

  Farmers Home Administration
  Assistance funds from the State
  Other grant sources (HUD, EDA, CSA, ARC, etc.)

- Review effluent requirements with state and EPA representatives to determine if a discharge variance could be obtained.

Attachment A

SOURCES OF INFORMATION

TYPE OF INFORMATION	RESPONSIBLE PARTIES	TYPICAL PUBLICATIONS
Population, personal income, family income	Local, county, or state planning departments; economic & community development districts; U.S. Census Bureau; state department of community affairs	Sub-state current population and income reports, local economic planning documents, and statistical reports
Information on existing and proposed sewer system project (capital costs, future operating costs)	Local or regional project management agency, local sewer departments, districts, or authorities	Sewer agreements, engineer feasibility studies, or financial analyses of projects
Local government financial information (property values, revenues, expenditures, debt, etc.)	Local or county finance officers, treasurers, town accountants or clerks. Local bankers or financial advisers	Local government budgets, financial statements, or annual reports

Attachment B

GLOSSARY OF FINANCIAL TERMS

Assets: Property owned by a goverment which has monetary value.

Balance Sheet: A statement presenting the financial position of an entity by disclosing the value of its assets, liabilities, and equities as of a specified date.

Bond: A written promise to pay (debt) a specified sum of money (called principal) at a specified future date (called the maturity date(s)) along with periodic payments at a specified percentage of the principal (interest rate).

Bond Rating: Letter designations used by credit rating agencies (Moody's and Standard & Poor's) to indicate relative credit quality of security (Moody's ratings from highest quality to lowest (Aaa, Aa, A, Baa, B (highly speculative), and C (default)).

Budget: A plan of financial operation giving an estimate of proposed expenditures for a given period (typically a fiscal year) and the proposed means of financing them (revenue estimates).

Capital Assets: Assets of significant value and having a useful life of several years. Capital assets are also fixed assets.

Capital Budget: A plan of proposed capital expenditures and the means of financing them. The capital budget is usually enacted as part of the complete annual budget which includes both operating and capital outlays.

Debt Service: Payment of interest and repayment of principal to holders of a government's debt instruments.

Deficit: (1) The excess of an entity's liabilities over its assets (See Fund Balance). (2) The excess of expenditures or expenses over revenues during a single accounting period.

Direct Debt: Debt which a government has incurred in its own name and relying on its own tax or other resources for repayment.

Expenditures: Depending on the type of accounting system used, either cash payments for goods received or services rendered, or the cost of such goods and services, whether cash payments have been made or not.

General Obligation Bonds: When a government pledges its full faith and credit and taxing power. Informally, to the repayment of the bonds it issues, the term is also to refer to bonds which are tax-supported, being repaid from taxes and other general revenues.

Household: As defined by the U.S. Census, a household consists of all the persons who occupy a housing unit. It includes related family members, unrelated persons such as lodgers, foster children, wards, or employees who share the housing unit, a person living alone, or a group of unrelated persons sharing a housing unit as partners. (Households include families.)

Liability: Debt or other legal obligations arising out of past transactions.

Long-Term Debt: Debt that is due with a maturity of more than 1 year.

Maturities: The dates on which the principal of debt obligations come due for payment.

Median Household Income: As defined by the U.S. Census, the total money income of a household that lies in the middle of the distribution of all household incomes (half of the households receive more and half receive less).

Net Direct Debt: General obligation (tax-supported debt) minus debt that is self-supporting (non-tax supported debt).

Non-tax-supported Debt: Debt that is repaid from sources other than general taxes of a jurisdiction and are not backed by its full taxing powers. (See revenue bond.)

Operating Surplus (or Deficit): The difference between current expenditure and current receipts during an accounting period (usually a year).

Overlapping Direct Debt: The proportionate share of debt of local governments whose boundaries overlap the unit in question. Usually calculated where several governments show a common tax base, such as counties, towns, and school districts that levy property taxes.

Personal Income: Total money income of residents as defined by U.S. Census. Total income from community is the per capita income multiplied by the total population of the community.

Property Tax Collection Rate: The percentage of the property tax year.

Reserve: An account used to indicate that assets are legally restricted for a specific purpose.

Revenue: The term generally represents current receipts from taxes, charges, and other proceeds from current operations.

Revenue (Limited Liability) Bonds: Bonds which do not pledge the full faith credit and taxing power of the jurisdiction. Typically, pledges are made to dedicate one specific revenue source to repay these bonds. Although some revenue bonds are based on special taxes, most are secured by fees and charges of an enterprise and, thus, are formally called "non-tax-supported debt."

Tax Rate: The percentage rate at which a municipality levies a tax.

True Value of Taxable Property: The market value of all real property within a jurisdiction that is subject to an ad valorem property tax. Not to be confused with the assessed property value which is the legal value at which properties are assessed for tax-paying properties and often is only a fraction of the true value.

Tax-supported Debt: Debt that is repaid from the general taxes of a jurisdiction and is backed by its full taxing power (see general obligation bond).

APPENDIX D

STATE HISTORIC PRESERVATION OFFICERS

STATE HISTORIC PRESERVATION OFFICERS

ALABAMA

Alabama Department of Archives & History
Chairman, Alabama Historical Commission
Archives and History Building
Montgomery, Alabama 36104
205/832-6510

ALASKA

Director, Division of Parks
323 East Fourth Avenue
Anchorage, Alaska 99501
206/583-0150 - (Ask for Anchorage, 274-4676)

ARIZONA

Director, State Parks Board
1688 West Adams
Phoenix, Arizona 85007
602/271-4174

ARKANSAS

State Historical Preservation Officer
Acting Director, Department of Natural and Cultural Heritage
The Old State House
300 West Markham
Little Rock, Arkansas 72201
501/371-1639

CALIFORNIA

Department of Parks & Recreation
State Resources Agency
Post Office Box 2390
Sacremento, California 95811
916/445-2358

COLORADO

State Historical Society
Colorado State Museum
200 14th Avenue
Denver, Colorado 8023
303/892-2136

CONNECTICUT

Connecticut Historical Commission
59 South Prospect Street
Hartford, Connecticut 06106
203/556-3005

DELAWARE

Division of Historical and Cultural Affairs
Hall of Records
Dover, Delaware 19901
302/678-4653

FLORIDA

Division of Archives, History & Records Management
Department of State
401 East Gaines Street
Tallahassee, Florida 32304
904/488-1480

GEORGIA

Acting Chief, Historic Preservation Section
Department of Natural Resources
270 Washington St., S.W., Rm. 703 C
Atlanta, Georgia 30334
404/656-2840

HAWAII

State Historic Preservation Officer
P.O. Box 621
Honolulu, Hawaii 96809
415/556-0220 - Ask for Honolulu, 548-2211

IDAHO

Historic Preservation Coordinator
Idaho State Historical Society
610 North Julia Davis Drive
Boise, Idaho 83706
208/384-2120

ILLINOIS

Department of Conservation
602 State Office Building
400 South Spring Street
Springfield, Illinois 62706
217/782-6302

INDIANA

Department of Natural Resources
608 State Office Building
Indianapolis, Indiana 42604
317/633-6344

IOWA

Director, State Historical Department
Division of Historic Preservation
B 13 McLean Hall
Iowa City, Iowa 52242
319/353-6949

KANSAS

Kansas State Historical Society
120 West 10th Street
Topeka, Karsas 66612
913/296-3251

KENTUCKY

Kentucky Heritage Commission
104 Bridge Street
Frankfort, Kentucky 40701
502/564-4476

LOUISIANA

Department of Art, Historical and Cultural Preservation
Old State Capitol, North Boulevard
Baton Rouge, Louisiana 70801
504/389-5086

MAINE

Maine Historical Preservation Commission
31 Western Avenue
Augusta, Maine 04330
207/289-2133

MARYLAND

State Historic Preservation Officer
The John Shaw House
21 State Circle
Annapolis, Maryland 21401
301/267-1440

MASSACHUSETTS

Executive Director, Massachusetts Historical Commission
294 Washington Street
Boston, Massachusetts 02108
617/727-8470

MICHIGAN

Director, Michigan History Division
Department of State
Lansing, Michigan 48918
517/375-0510

STATE HISTORIC PRESERVATION OFFICERS

MINNESOTA

Minnesota Historical Society
690 Cedar Street
St. Paul, Minnesota 55101
612/296-2747

MISSISSIPPI

State of Mississippi
Department of Archives and
History
Post Office Box 571
Jackson, Mississippi 39205
601/354-6218

MISSOURI

Director, Missouri Department
of Natural Resources
P.O. Box 176
1204 Jefferson Building
Jefferson City, Missouri 65101
314/751-4422

MONTANA

Recreation and Parks Division
Department of Fish and Game
Mitchell Building
Helena, Montana 59601
406/449-2535

NEBRASKA

The Nebraska State Historical
Society
1500 R Street
Lincoln, Nebraska 68508
402/432-2793

NEVADA

Division of State Parks
Room 221, Nye Building
Capitol Complex
Carson City, Nevada 89701
702/885-4370

NEW HAMPSHIRE

Department of Resources and
Economic Development
P.O. Box 856
Concord, New Hampshire 03301
603/271-2411

NEW JERSEY

Department of Environmental
Protection
Post Office Box 1420
Trenton, New Jersey 08625
609-292-2885

NEW MEXICO

State Historic Preservation
Officer
State Capitol
403 Capitol Building
Santa Fe, New Mexico 87501
505/827-2974

NEW YORK

Parks and Recreation
Agency Building #1
Empire State Plaza
Albany, New York 12223
518/474-0468

NORTH CAROLINA

Director, Division of Archives
and History
State Historic Preservation Officer
Department of Cultural Resources
190 East Jones Street
Raleigh, North Carolina 27611
919/829-7305

NORTH DAKOTA

State Historical Society of North Dakota
Liberty Memorial Building
Bismarck, North Dakota 58501
701/224-2667

OHIO

The Ohio Historical Society
Interstate 71 at 17th Avenue
Columbus, Ohio 43211
614/466-3852

OKLAHOMA

State Historic Preservation Officer
1108 Colcord Building
Oklahoma City, Oklahoma 73102
405/236-3571

OREGON

State Parks and Recreation
300 State Highway Building
Salem, Oregon 97310
503/378-6305

PENNSYLVANIA

Pennsylvania Historical and Museum
Commission
Box 1026
Harrisburg, Pennsylvania 17108
712/787-2891

RHODE ISLAND

Rhode Island Department of Community
Affairs
150 Washington Street
Providence, Rhode Island 02903
401/277-2850

SOUTH CAROLINA

State Archives Department
1430 Senate Street
Columbia, South Carolina
803/758-5816

SOUTH DAKOTA

Director, Office of Cultural Preservation
Department of Education and
Cultural Affairs
State Capitol
Pierre, South Dakota 57501
605/224-3458

TENNESSEE

Tennessee Historical Commission
170 Second Avenue North
Suite 100
Nashville, Tennessee 37219
615/741-2371

TEXAS

Texas Historical Commission
P.O. Box 12276
Capitol Station
Austin, Texas 78711
512/475-3092

UTAH

Division of State History
603 East South Temple
Salt Lake City, Utah 84102
801/533-5755

VERMONT

Vermont Division of Historic
Sites
Pavilion Building
Montpelier, Vermont 05602
802/828-3226

VIRGINIA

Executive Director,
Virginia Historic Landmarks
Commission
221 Governor Street
Richmond, Virginia 23219
804/786-3143

STATE HISTORIC PERSERVATION OFFICES

WASHINGTON

State Conservator
P. O. Box 1128
Olympia, Washington 98504
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WEST VIRGINIA

West Virginia Antiquities
Commission
P.O. Box 630
Morgantown, West Virginia 26505

WISCONSIN

State Historical Society of Wisconsin
816 State Street
Madison, Wisconsin 53706
608/262-3266

WYOMING

Wyoming Recreation Commission
604 East 25th Street
Box 309
Cheyenne, Wyoming 82001
307/777-7695

DISTRICT OF COLUMBIA

Acting Director, Office of Housing
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